

CHAPTER 13 CONSTRUCTION PLAN AND PRELIMINARY COST ESTIMATE

13.1 PROJECT IMPLEMENTATION PROGRAM

The Simanggo-2 Hydropower Project (hereinafter referred to as “the project,”) was formulated as a run-of-river type development and proposed to conduct a pre F/S in the framework of the study. The project consists of major structures, namely: 1) intake weir, 2) intake and sand trap, 3) connection tunnel, 4) intermediate pond and pond dike, 5) headrace tunnel, 6) surge tank, 7) drain tunnel, 8) underground penstock, 9) powerhouse, 10) tailrace, 11) switchyard, and 12) transmission line. The construction items incorporated in the project are summarized in Table 13.1.1 and the layout of project facilities is shown in Drawing No.S-100. The construction of site access roads, preparatory works, river diversion, etc., is also stated in this chapter.

Table 13.1.1 Construction Items Included in the Project

Category	Structure/Equipment
Civil Works	Intake Weir, Intake, Sand Trap, Connection Tunnel, Intermediate Pond and Pond Dike, Headrace Tunnel, Surge Tank, Drain Tunnel, Underground Penstock Line, Powerhouse, Tailrace, Switchyard, Transmission Line
Hydro-Mechanical Works	Gates, Valves, Trash rack, Stoplogs, River Outlet Steel Pipes and Valves, Penstock Pipe, Draft Tube Gate
Electro-Mechanical Works	Turbines, Generators, Main Transformers, Control Equipment, Switchgear, Transmission Line

Source: JICA Study Team

The overall implementation schedule the project proposes as shown in Figure 13.1.1 started with the year 2011. The project would require about six (6) years including transaction activities of about three (3) years and construction period of three (3) years started with the year 2014 after the completion of this pre-feasibility study in the year 2011 to enable commissioning by November 2017. Implementation items to be incorporated are listed as follows:

- Financial arrangement for further study
- Feasibility study and supplemental survey
- EIA study
- Land acquisition, compensation and resettlement
- Procurement of consultant
- Detailed design and preparation of tender documents

- PQ, tender, tender evaluation and award of contract
- Construction

It is expected that financial source the project will be Japan's ODA loan for the further study and construction execution.

It is planned that the project will be implemented under the responsibility of the PLN. The construction works will be executed by the selected contractor through international competitive bid (ICB). The engineering consultant will be employed for feasibility study, detailed design and construction supervision.

It is planned that the construction of site access roads will have to be conducted by the local contractor separating and advancing the main works under local competitive bid (LCB) under financing the local budget for the purpose to shorten the construction period of the main works and to meet to commence the target time the commercial operation in November 2017.

	Description	Unit	Q'ty	2010			Year 1 (2011)			Year 2 (2012)			Year 3 (2013)			Year 4 (2014)			Year 5 (2015)			Year 6 (2016)			Year 7 (2017)					
				7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9
I	Preconstruction Activities																													
	1 Pre-feasibility Study	-	-																											
	2 Financial arrangement	-	-																											
	- Foreign loan nego & agreement																													
	- Indonesia national budget																													
	3 Supplemental survey	-	-																											
	4 EIA	-	-																											
	5 Land acquisition/re-settlement	-	-																											
	6 Publication of approved EIA	-	-																											
	7 Procurement of consultant	-	-																											
	8 Detailed design & tender documents Preparation	-	-																											
	9 PQ for ICB tender	-	-																											
	10 International tender & evaluation	-	-																											
	11 Contract award	-	-																											
II	Construction, Simanggo-2																													
	1 Site access road by local fund/tender	-	LS																											
	2 Mobilization/Preparatory works	-	LS																											
	3 Civil works																													
	1) River diversion works	-	LS																											
	2) Intake weir, intake, sand trap	-	LS																											
	3) Waterway, connection tunnel , horse-shoe, D3.9m	m	1,570																											
	Waterway, connection tunnel , horse-shoe, D3.9m	m	1,570																											
	Waterway, connection tunnel , horse-shoe, D3.9m	m	1,570																											
	Waterway, intermediate pond, water surface area	ha	12																											
	Work adit-1 for headrace tunnel	m	300																											
	Waterway, headrace tunnel, circular, D3.9m	m	300																											
	Waterway, headrace tunnel, circular, D3.9m	m	2,830																											

13.2 CONSTRUCTION PLAN AND SCHEDULE

13.2.1 CONSTRUCTION PLAN

(1) Scope of Works

The major work items and its quantities are calculated from the pre-feasibility design and summarized in Table 13.2.1 below.

Table 13.2.1 Major Work Items and Its Quantities of Simanggo-2 HEPP

	Work item	Quantity
(1)	Access road	
	- Access road, new 4m carriage way	: 6.3 km
	- Existing road improvement	: 1.2 km
	- Bridge	: 4 sets
(2)	Preparatory works	: LS
(3)	Environmental mitigation works during construction	: LS
(4)	Diversion weir, intake and sand trap	
	- Excavation	: 149,000 m ³
	- Concrete, mass	: 8,000 m ³
	- Concrete, structural	: 19,200 m ³
	- Foundation grouting, 10mx50 nos.	: 550 m
(5)	Connection tunnel (D3.9m, L 1,570 m)	
	- Excavation, open	: 9,500 m ³
	- Excavation, underground	: 25,300 m ³
	- Tunnel support	: LS
	- Concrete lining	: 5,500 m ³
(6)	Intermediate pond (water surface area 12.0ha)	
	- Excavation for structural foundation	: 148,000 m ³
	- Dike embankment, rock fill with blanket	: 327,000 m ³
	- Foundation seepage cutoff sheetpile	: 560 t
	- Slope stabilize horizontal drain holes	: 14,000 m
	- Concrete, open structures	: 8,600 m ³
(7)	Headrace tunnel (D3.9m, L3,980 m), surge tank & drain tunnel (D4.6m, L100m)	
	- Excavation, open	: 8,600 m ³
	- Excavation, tunnel	: 87,000 m ³
	- Excavation, shaft	: 5,100 m ³
	- Tunnel support	: LS
	- Concrete lining	: 32,400 m ³
	- Consolidation grouting	: 28,500 m
	- Work adit, L 300 m	: LS
(8)	Penstock line, underground (penstock pipe dia. 3.2m, tunnel dia. 4.6m, L615m)	
	- Excavation, open, penstock	: 8,600 m ³
	- Excavation, horizontal tunnel	: 6,900 m ³
	- Excavation, inclined shaft	: 5,800 m ³

	- Concrete, encasement	: 6,300 m ³
(9)	Powerhouse, above ground	
	- Excavation, open powerhouse	: 63,000 m ³
	- Earth backfill	: 8,500 m ³
	- Concrete powerhouse	: 9,300 m ³
	- Architectural finish & utility	: LS
(10)	Steel and mechanical works	
	- Sand flushing gate, 5mx4m, 1 no.	: 30 tons
	- Sand flushing stoplog, 5mx4mx, 1 no.	: 20 tons
	- River outlet slide valves, D0.5m, 2 nos.	: LS
	- Intake trash rack	: 16 tons
	- Intake gate, 2 nos.	: 60 tons
	- Intake stoplog, 1 no.	: 30 tons
	- Sand drain gate, 2 nos.	: 6 tons
	- Settling basin, end stoplog	: 38 tons
	- Connection tunnel inlet stoplog gate	: 39 tons
	- Connection tunnel outlet stoplog	: 32 tons
	- Pond river outlet steel pipe, D0.5mx100m	: 12 tons
	- Pond river outlet emergency valve, D0.4m	: LS
	- Pond river outlet service valve, D0.4m	: LS
	- Draft tube stoplog, 2 nos.	: 28 tons
	- Penstock pipe, D3.2m	: 1,460 tons
(11)	Generating equipment and switchyard equipment (90 MW)	
	- Turbines	: 2 units
	- Generators	: 2 units
	- Control equipment	: 1 lot
	- Others	: 1 lot
(12)	Transmission line	
	- Transmission line, 150 kV	: 10 km

Source: JICA Study Team

(2) Site Conditions

Existing access to the site

The Simanggo-2 HEPP is administratively located in Humbang Hasundutan Regency, North Sumatra Province. The project is located approximately 30 km from Doloksanggul, the capital city of Humbang Hasundutan Regency. The following is major access route to the project site.

- Medan -> Tebingtinggi -> Prapat -> Siborongborong -> Doloksanggul -> Parlilitan -> project site
- Medan -> Berastagi -> Sidikalang -> Doloksanggul -> Parlilitan -> project site

Topography

The Simanggo river runs on the west slope of the Barisan Mountains and originates from Mt. Simanggo Dungi (El. 1,460.0m) and the Mt. Ginjang (El. 1,685.2m). The river flows too southwest, then joins the Lae Cinendang river and finally discharges into the Indian Ocean. Catchment area of the

Simanggo-2 HEPP is about 480 km².

Meteorology and hydrology

Average annual rainfall is 3,150 mm. Mean runoff of the Simanggo river at the weir site is estimated at 26.9 m³/sec. The average daily rainfall under 5 mm is 250 days per year. Wet season in the project area characteristics in 2 times that August to December and March to April. Average air temperature is max. 31°C and min. 22°C.

Geology

Based on the exposed rocks along the river valley, the tuffs are partially melted and generally very massive with a few joints. On the other hand, the Late Carboniferous to Early Permian Kluet formation mainly includes quartzites, slate, siltstones and phyllites and these rock units will be expected to be encountered along the proposed waterway route.

Sandstone quarries, quarry 1 at near intake and quarry 2 at near powerhouse will be used as the source of concrete aggregates. Sand stone quarry prospects at near intermediate pond. The riverbed sediments, including coarse sands, gravels and boulders of andesite and sandstone origins, will also be used as fine and coarse aggregates of concrete.

Construction resources

Major construction resources for the Project will be procured from following sources based on site reconnaissance and hearing survey:

Labor force	1) Skilled	: Medan and Jawa
	2) Semi-skilled	: North Sumatra
	3) Common	: Project site
Materials	1) Cement	: Padang, Medan
	2) Reinforced steel bar	: Jawa, Sumatra
	3) Shaped steel, H, I	: Jawa
	4) Concrete aggregates	: Project site
	5) Fuel and lubricants	: Medan
Plant/Equipment	1) Earthmoving equipment	: Medan, Jawa
	2) Tunneling equipment	: Import
	3) Concreting	: Medan, Jawa
	4) Crane	: Medan, Jawa

Cargo transportation

Handling of project's sea cargo is Belawan Sea Port in Medan that operates 24 hours. The port is facilitates mobile crane, head truck, trailer, fork lift and other equipment for heavy cargo handling. The existing public roads via Tebingtinggi Prapat and Doloksanggul will be the major route for inland transportation of project's cargoes. Sibolga sea port will be surveyed in the further study as an alternative.

(3) Yearly Working Days

Working days for typical construction work are assumed as follows considering suspended days of 48 days for Sunday, 14 days for National holiday, 7 days for Hari Raya, and rainfall data that the work suspended over the daily rainfall of 5 mm that assumes 115 days (365 days – 250 days).

Earth works, open	: $365 - (48+14+7) = 296$ days
	$365 - 115 = 250$ days
Concrete works	: 250 days
Tunnel works	: 296 days

Working hours are from 8:00 to 17:00, including one hour for lunch. Amount is to 48 working hours per week, from Monday to Saturday.

(4) Preparatory Works

Site access road

The following site access roads having about 4m of carriage way are planned as shown in Drawing No. GR-001 and to be constructed or improved by the local contractor.

Road	AR1 New, between existing road and intake site
	AR2 Improve, between existing road and intermediate pond
	AR3 New, between existing road and pond dike
	AR4 New, between AR3 and headrace tunnel inlet
	AR5 New, between AR2 and spoil bank 1 and 2
	AR6 New, between existing road and Simanggo river
	AR7 New, between AR6 and powerhouse
	AR8 New, between AR7 and surge tank
	AR9 New, between AR8 and work adit
Bridge	BR1 New, crossing tributary on the AR2
	BR2 New, crossing tributary just downstream of the pond dike
	BR3 New, crossing the Simanggo river and connect AR6 and AR7
	BR4 New, crossing tributary on the AR7

Spoil banks

Excavation volume assumes at about 0.7 million m³ in total for all the structures of civil works. The excessive excavated materials are spoiled to the designated spoil banks that propose at 6 places, SB1 to SB6, as shown in Drawing No.S-100. However, excavated materials should be planned to use effectively such as concrete aggregates, road maintenance, low land reclamation and others.

Base camp and plant yard

The contractor's base camp and plant yard will be located in 2 places of intake site and powerhouse site due to inconvenient site access as shown in Drawing No.S-100. The total land area of the camp and plant yard is assumed to be about 2 ha.

(5) Temporary Facilities

Temporary construction facilities such as buildings, plant and plant yard, laboratory, workshop, warehouse and magazine will also be provided.

Concrete mixing plant

The total concrete volume is estimated at about 100,000 m³, including allowances. No ready mixed concrete factory is found around the project site that needs to provide concrete production facility by the contractor. The required mixing capacity of the plant is to be estimated based on the peak monthly placing volume.

Aggregate plant

To supply concrete aggregates, it is necessary to define the supply source from rock quarry or commercial supplier. Potential quarry site, quarry 1 at intake site and 2 at powerhouse side proposes as shown in Drawing No.S-100. One more quarry prospects near the intermediate pond. The required aggregate plant capacity is to be calculated based on the peak concrete requirement, in case to own production.

Water supply system

Water supply is required for places such as the contractor's office and camp, construction plant, repair shop, tunnel headings, and tunnel portals. The Simanggo river and tributaries will be the water source for construction and drinking upon treatment.

Power supply system

No public power is available in the construction site of intake, intermediate pond, work adit and powerhouse. Thus, the contractor is responsible for the provision of diesel generators or extension of public power lines from nearest public distribution line for construction use.

Air supply system

Since the main drilling operation for tunnel blasting work will be planned to involve hydraulic drifters equipped in the tunnel jumbo, air requirement is not very large. However, some auxiliary equipment need compressed air supply that will be supplied by engine-driven portable air compressor provided at the tunnel portal.

Ventilation system

There are three independent sources of air contamination in the tunneling work, namely: 1) exhaustion of workers, 2) blasting, and 3) diesel engines. Since muck truck system will be adopted, diesel powered engines will produce the most contamination among the three elements. Thus, ventilation facilities will be planned so as to overcome gas emissions from engine-driven equipment used in the tunnel. The required ventilation volume should be calculated in a further study.

Tunnel drainage system

Seepage water into the tunnel will be drained in the following manner:

Site	Drainage method
Connection tunnel	Gravity from pond side portal and pump up from intake side
Headrace tunnel	Gravity from the work adit and surge tank side tunnel portal, and pump up from the work adit and pond side tunnel portal
Powerhouse	By pumping-up
Intake	By pumping-up

Telecommunication system

Telecommunication system requires in the project site such as internal telephone, external telephone, radio hand phone, and mobile phone

(6) Main Civil Works

Diversion weir, intake and sand trap

The technical features and work quantities for major items on these works are as follows:

- Type of weir	Un-gated concrete weir
- Type of intake	Screened horizontal inlet
- Type of sand trap	Double settling basins
- Height, overflow section	10 m
- Foundation excavation	149,000 m ³
- Mass concrete	8,000 m ³
- Concrete, structural	19,200 m ³
- Foundation grouting, 10mx 55 nos.	550 m
- River diversion works	LS
- Hydro-mechanical works	1 lot

The intake weir will be constructed in three stages using the multiple river diversion method, which shall provide a cofferdam along the river.

1st stage: A temporary cofferdam will be constructed using rock, gravel, and soil to divert river flow to the left side channel and allow construction of the structures situated in the right bank side. Mass concrete works for the right section of the weir body will resume in the third stage.

2nd stage: The construction works are shifted to the left bank section and river flow is diverted to the right side channel and to construct remaining section of the weir.

3rd stage: This stage will cover placement of mass concrete for the remaining block of the right weir section. The river will flow through sand flush and sand flushing channel.

The excavation for the diversion weir, intake and sand trap will be carried out using a 21 ton bulldozer equipped with ripper, 1.2 m³ backhoe, and 15 ton dump truck. An 800 kg giant breaker will be used for rock excavation. Mass and structure concrete will be poured through a chute way or a 3.0 m³

concrete bucket with 30 ton crawler crane, 3 m³ class agitator truck, and a concrete mixing plant.

Construction period will be scheduled at about 33 months for 1st, 2nd and 3rd stages including dry seasons.

Connection tunnel

The technical features and work quantities for major items on the connection tunnel are as follows:

- Type	Free flow tunnel, horse-shoe
- Tunnel diameter	D3.9 m
- Length of tunnel	1,570 m
- Excavation, tunnel	25,300 m ³
- Tunnel lining concrete	5,500 m ³

It is assumed that full-face excavation by 2 headings, from up and downstream side will be generally performed throughout the tunnel by applying the conventional method of drilling and blasting. However, top and bottom bench cut method might be required in some parts, depending on the current geological condition. Pilot boring from the cut face are recommended to forecast the geological condition and ground water. No work adit is planned in the connection tunnel.

The excavation will be carried out providing two headings of ascending from downstream side and descending from upstream side applying drill jumbo. A standard progress of excavation assumes at 60 m/month per heading. Tunnel support will be required by applying steel rib, shotcrete, wiremesh, rock bolt and forepoling. To drain unexpected water during the excavation, drainage system is to be provided.

The concrete lining follows after the driven of whole length the tunnel. A standard progress assumes at 120 m/month for arch and wall applying steel sliding form and 500 m/month for inverts. The backfill grout follows the concrete lining.

Intermediate pond and dike

The technical features and work quantities for major items on intermediate pond are as follows:

- Type of pond	Natural creek
- Water surface area	12.0 ha
- Gross storage volume	1.45 MCM
- Excavation, structural foundation	148,000 m ³
- Dike embankment, rockfill with blanket	327,000 m ³
- Foundation seepage cutoff sheetpiles	560 t
- Slope stabilize horizontal drain holes	14,000 m
- Concrete, open structures	8,600 m ³

Major work is construction of pond dike. Embankment volume of the dike is 0.33 million m³. Embankment materials will be taken from river deposits and proposed quarries. Further survey requires for the source of embankment materials. Standard type of construction equipment will be

applied for the embankment works such as 12 tons class bulldozer, 0.6 m³ class backhoe, 1.5 m³ class crawler loader, 15 tons class dump truck, 10-20 tons class compactor. Driving the cutoff sheetpiles will be done by applying 60 kW class vibration hammer. Structural concrete works carry out in parallel with the dike embankment applying 3 m³ class agitator truck and others, provided 2 to 3 construction parties. A standard progress of huge amount of embankment work plans at about 130 m³/hour in 20 months construction period.

Headrace tunnel, surge tank and drain tunnel

The technical features and work quantities for major items on the headrace tunnel, surge tank and drain tunnel are as follows:

- Type of headrace tunnel	Pressure flow tunnel, circular
- Headrace tunnel diameter and length	D3.9 m, L3,980 m
- Type of surge tank, diameter & height	Vertical shaft, D8.5 m, H60 m
- Type of drain tunnel	Horse shoe
- Drain tunnel diameter and length	D4.6 m, L100 m
- Excavation, open	8,600 m ³
- Excavation, tunnel	87,000 m ³
- Rock support	LS
- Excavation, shaft	5,100 m ³
- Tunnel lining concrete	32,400 m ³
- Consolidation grouting	28,500 m

(Headrace tunnel)

It is assumed that full-face excavation will be generally performed throughout the headrace tunnel by applying the conventional method of drilling and blasting. However, top and bottom bench cut method might be required in some parts, depending on the current geological condition.

The construction of the headrace tunnel will be carried out applying the following method and schedule provided with work 2 work adits, work adit-1 and -2, which show the location in Drawing No. S-100:

1st step: Excavation will proceed at the following 3 places concurrently;

- 1) Descending driven from headrace tunnel inlet side by 1 heading,
- 2) To driven work adit-1 at intermediate point and about 300 m long, and
- 3) To driven work adit-2 and at surge tank side with about 300 m long.

2nd step: To driven the drain tunnel at surge tank side branched from work adit-2

3rd step: Excavation continue at the following 4 headings of the headrace tunnel;

- 1) Descending driven from headrace tunnel inlet side for 1,415 m long,
- 2) Ascending driven from work adit-1 for 1,415 m long,
- 3) Descending driven from work adit-1 for 425 m long, and

4) Ascending driven from work adit-2 for 425 m long

A standard progress of excavation assumes at 100 m/month per heading. The work adit-1 and 2 will be driven in 3 months for 300 m long respectively. The main tunnel of 3,980 m will be driven in about 19 months work period attacked by 4 headings. Drill jumbo of 4 sets is required to mobilize in the 3rd step. Tunnel support will be required by applying shotcrete, wiremesh, rock bolt and forepoling. Pilot boring from the cut face are recommended to forecast the geological condition and ground water. To drain unexpected water during the excavation, drainage system is to be provided. The work sequence of the phased excavation work including the supporting work will be planned as follows:

Drilling Blast Hole:

Two boom hydraulic wheel jumbos will be employed during drilling.

Loading Explosive:

Loading and wiring for blasting will be done by three powder men. The charge rate of explosives is to be estimated in further study stage upon detailed geological survey.

Blasting and Ventilation:

After withdrawal of tunnel jumbo from the heading, the explosives will be triggered with electric detonators. Ventilation of blast fumes will require.

Mucking:

Wheel type side dump loader equipped with a rock bucket will be used for loading of muck into dump trucks. The tunnel width is 4.6 m. To enable easy maneuvering of dump trucks and easy passage of two trucks inside the tunnel, a turning space is necessary to be provided with over-cut of the tunnel wall.

Shotcrete:

After mucking operation is completed, steel fiber reinforced concrete will be poured through shotcrete on the tunnel arch and side walls.

Rock Bolt:

Rock bolts will be placed, keeping the designated spacing in between. Full-bond rock bolt type with cement mortar will be used. The hole will be drilled using tunnel wheel jumbo.

The daily progress rate is assumed to be 4.0 m, and there will be three blast works per day by drilling 1.5 m long per time. Dewatering in the tunnel will be by gravity method through the drainage ditches for descending excavation and by pumping drainage for ascending excavation.

The concrete lining follows after the driven of whole length the tunnel. A standard progress assumes at 150 m/month and 1000 m/month for arch and wall and invert respectively applying steel sliding form.

The side wall and invert of the tunnel will be lined with 25 cm thick reinforced concrete after excavation of the whole length. The arch and side wall will first be applied with concrete and then the invert will follow. Concrete works will be carried out in opposite directions from the center of the tunnel.

Concrete will be transported to the site by 4.5 m³ truck mixers and placed using a concrete pump with a capacity of 60 m³/hr. Following the concrete works, backfill mortar will be used to fill up gaps between the concrete lining and the surrounding rock.

(Surge tank and drain tunnel)

Drain tunnel branching from the work adit-2 will be constructed first applying the same method of connection tunnel advancing the construction of surge tank.

The excavation of 60 m height vertical shaft will be commenced after the driven of drain tunnel. A pilot hole is driven first upward from the bottom portion of the surge tank by raise climber. Enlargement excavation continues by using light class excavator and excavated muck hauls to the pilot hole to haul outside spoil bank via drainage tunnel. Concrete works follow the shaft excavation.

Penstock line

The technical features and work quantities for major items on the surge tank is as follows:

- Type of penstock	Underground penstock
- Steel pipe diameter	D3.2 m
- Length of penstock	615 m
- Diameter of inclined and horizontal tunnel	4.6 m
- Pipes after Y-branch	D1.9 m x 55 m x 2 nos.
- Excavation, open, penstock	2,500 m ³
- Excavation, horizontal tunnel	6,900 m ³
- Excavation, inclined shaft	5,800 m ³
- Concrete, encasement	6,300 m ³

The excavation of penstock tunnel will be done from the powerhouse side. The same method of the headrace tunnel will be applied for tunnel excavation of horizontal part of 195 m. For the excavation of inclined shaft, a pilot hole will be driven by ascending excavation applying raise climber and blasting method. The shaft enlarges after the driven of pilot hole of 315 m. The excavated muck of enlargement are hauled out to outside through the pilot hole and horizontal tunnel.

Light class equipment, bulldozer and backhoe, will be applied for the enlargement. Winch will be helped for safety construction operation.

Powerhouse

The technical features and work quantities for major items on the powerhouse are as follows:

- Type of powerhouse	Above-ground type
- Building structure	Reinforced concrete
- Tailrace	open channel
- Excavation, open powerhouse	63,000 m ³
- Earth backfill	8,500 m ³
- Concrete, powerhouse	9,300 m ³
- Architectural finish & utility	LS

Standard type of earthmoving and concrete equipment will be used for the construction of powerhouse

that is 16 t bulldozer, 0.6 m³ excavator, 15 t dump truck, 3 m³ agitator truck, 60 m³/hr concrete pump car and others.

An overhead traveling crane with a lifting capacity of 50 tons will be installed in the powerhouse until the end of April 2016 in order to assure the commencement of installation works of generating equipment. The installation of two sets of turbines and other hydro-mechanical and electro-mechanical equipment will be carried out using the overhead traveling crane.

Commissioning of the power station is scheduled in the beginning of November 2017, after two month period for dry and wet test.

(7) Hydro-Mechanical Works

Hydro-mechanical work items and quantities which are required for the Project are summarized as follows:

1) Sand flushing gate (SFG), 5mx4m	1 set	30 tons
2) Sand flushing stoplog, 5mx4m	1 set	20 tons
3) River outlet valves, D0.5m slide valve	2 sets	LS
4) Intake trashrack	1 set	16 tons
5) Intake gate	2 sets	60 tons
6) Intake stoplog	1 set	30 tons
7) Sand drain gate	2 sets	6 tons
8) Settling basin, end stoplog	1 set	38 tons
9) Connection tunnel inlet stoplog gate	1 set	39 tons
10) Connection tunnel outlet stoplog	1 set	32tons
11) Pond river outlet steel pipe, D0.5mx100 m	1 lot	12 tons
12) Pond river outlet emergency valve, D0.4m	1 lot	LS
13) Pond river outlet service valve, D0.4m	1 lot	LS
14) Draft tube stoplog	2 sets	28 tons
15) Steel penstock, D3.2 m	1 lane	1,460 tons

Figure 13.1.1 shows the construction time schedule for hydro-mechanical works including the design, manufacturing, transportation, and installation works after the award of contract, which is assumed to be in October 2014. The design, manufacturing and transportation of steel penstocks are scheduled for 18 months in order to ensure the commencement of the installation works, which is scheduled to be completed within 15 months.

Installation works will be carried out combining mechanical equipment and manual power. The major equipment for the installation works will be truck crane, crawler crane, dump truck, winch for penstock installation, etc.

(8) Electro-Mechanical Works

The electro-mechanical work items and quantities required for the Simanggo-2 HEPP are summarized as follows:

- Turbine, Horizontal Francis type	2 sets
- Generator, 3-phase, synchronous	2 sets

- Control equipment	1 lot
- Others	1 lot

Figure 13.1.1 also shows the construction time schedule for the electro-mechanical works, including design, manufacturing, transportation, and installation works.

The design, manufacturing and transportation of electro-mechanical equipment are scheduled for 18 months in order to ensure the commencement of the installation works, which are plans at 15 months and also an essential part of the project. Heaviest equipment for the electro-mechanical works is transformer of approx. 40 tons which will be transported by trailer of 30 tons class that needs careful planning the inland transportation and installation works. Other electro-mechanical works will have to be conducted in order to meet the proposed construction time schedule.

The Francis type turbine and its ancillaries are installed through the use of manual power and an overhead traveling crane with 50 ton lifting capacity and other equipment. The installation period will be 17 months including dry and wet test of 2 months. Its commissioning date is scheduled to be November, 2017.

(9) Transmission Line

A 10 km long transmission line (T/L) with a capacity of 150 kV is connected to the substation of which will be constructed by PLN located near the intake site the project. The T/L tower having about 100 m² foundation base will be planned to construct at 350 m long interval.

13.2.2 CONSTRUCTION SCHEDULE

(1) Construction Sequence

It was proposed that site access roads of about 7.5 km long including 4 bridges are to be constructed advancing the main works the project under local finance and local contractor to shorten the main civil works. The construction of the site access roads is scheduled to start in May 2014 and be completed in 17 months construction period. The site access road are constructed giving the priority, to commence the headrace tunnel excavation on time.

The civil works will have to schedule to conduct almost in parallel at the major structure site of 1) intake, 2) connection tunnel, 3) intermediate pond, 4) headrace tunnel, 5) surge tank, 6) penstock line, and 7) powerhouse.

(2) Construction Time Schedule

An overall implementation period of the project plans at about 6 years as presented in Figure 13.1.1. Those 3 years for pre-construction activities of feasibility study, EIA, detailed design and other activities and 3 years for the construction works.

The construction period of Simanggo-2 HEPP assumes at 36 months in total started with November 2014 in order to achieve commissioning by November 2017.

It is anticipated that the critical path of the construction works will be the 3,980 m long headrace tunnel works, which include construction of portal, excavation, concreting, and backfill grout of main tunnel. To ensure the targeted date of commissioning, 2 work adits are planned to be constructed in the headrace tunnel.

The construction of the 3,980 m long headrace tunnel schedules at 33 months in total work period under the following breakdown:

Work item	Work period	Monthly progress
Main tunnel, 3,980 m, excavation	19.0 months	100 m/month/heading
Main tunnel, 3,980 m, arch & wall concrete	12.0 month	150 m/month/party
Main tunnel, 3,980 m, backfill grout	2.0 months	1,600 m/month/party

13.3 PRELIMINARY COST ESTIMATE

13.3.1 CONDITIONS AND ASSUMPTIONS FOR COST ESTIMATE

The conditions and assumptions for the cost estimate in this pre-feasibility study stage of Simanggo-2 HEPP are as follows:

- Base year for the cost estimate is 2010.
- Fiscal year is January – December
- Exchange rate: US\$ 1.0 = Rp. 9,000.0 = JPY 82.0
- The cost is estimated divided into the foreign currency portion (FC) and local currency portion (LC) on the following items:
 - Construction cost with VAT
 - Land acquisition, compensation and resettlement cost
 - Administration cost of executing agency
 - Engineering services cost
 - Price and physical contingencies
- The construction cost includes the environmental mitigation cost during construction such as environmental monitoring, treatment cost for muddy water, protection cost for dust and noise, forest royalty cost, compensation cost for plantation products and other negative affection on environment.
- The cost for EIA (Environmental Impact Assessment) is incorporated into the engineering services cost by man-month basis including indirect cost in the

feasibility study stage to assess flora, fauna, aquatic fauna and other impact.

- The cost for land acquisition and resettlement cost includes the preparation of the cost for resettlement action plan and its monitoring cost.
- The estimated cost is expressed in USD and Rp. for FC and LC portions respectively.
- Unit rates of construction cost applied for civil works is estimated referring to the other hydropower projects under implemented or implementing recently in Indonesia.
- Costs for hydro-mechanical and electro-mechanical equipment works are estimated on the basis of the consultant's database related to recent international bid prices for similar works.
- The contractor's overhead cost and profit are included into the unit rates of construction cost.
- Value Added Tax (PPn) is 10% of the direct construction cost and incorporated into the LC portion.
- Land acquisition and resettlement cost is estimated referring the micro hydro project of IPP in 2009 and others in Indonesia.
- Administration cost of executing agency is estimated at 5% in proportion to the direct construction cost excluding the VAT portion.
- Engineering costs is estimated on a man-month basis for consulting engineers in principle.
- Price contingency is accounted at 1.3% and 5.0% per annum for foreign portion and local portion respectively.
- Physical contingency covers unforeseeable matter during construction that is assumed at 10% for all the cost items.
- The share between the foreign portion and local portion is estimated at 40%:60%.
- The annual disbursement schedule is provided based on the estimated costs and overall implementation schedule.

13.3.2 UNIT RATES

The applied unit rates are indicated in the Table 13.3.1 for the priced bills of quantities of the construction cost of the Simanggo-2 HEPP.

13.3.3 PROJECT COST

The project cost for the Simanggo-2 HEPP presents in Table 13.3.2. Annual disbursement schedule is seen in Table 13.3.3

Table 13.3.1 Priced Bill of Quantities for Simanggo-2

				US\$ 1.0 = 9,000 Rp.		5 hr peak kW		90,000	
No.	Construction Work Items	Unit	Qquantity	Unit Rates, Pre-FS2011			Amount, Pre-FS2011		Total, FC+LC
				FC (US\$)	LC (Rp.)	Total (US\$)	FC (US\$)	LC (Rp.)	(US\$ mil.)
I	CIVIL WORKS								
I.1	Diversion Weir, Intake and Sand Trap								
	1) Excavation, all classes	m³	149,000	3.6	27,060	6.6	536,400	4,031,940,000	0.98
	2) Earth backfill	m	19,000	4.0	16,280	5.8	76,000	309,320,000	0.11
	3) Concrete, mass	m³	8,000	30.0	630,000	100.0	240,000	5,040,000,000	0.80
	4) Concrete, structure w/form	m³	19,200	30.0	1,080,000	150.0	576,000	20,736,000,000	2.88
	5) Re-bar	t	1,250	6	15,828,792	1,764.8	7,500	19,785,990,000	2.21
	6) Foundation grouting (10mx55nos.)	m	550	30.0	630,000	100.0	16,500	346,500,000	0.06
	7) Miscellaneous, 15% of 1) to 6)	-	LS				0	9,498,202,500	1.06
	8) River diversion works, 20% of 1) to 7)	-	LS				485,464	10,194,737,350	1.62
	Subtotal I.1						1,937,864	69,942,689,850	9.7
I.2	Connection Tunnel , free flow (D3.9m, L1,570m)								
	1) Open excavation, all classes	m³	9,500	3.6	27,060	6.6	34,200	257,070,000	0.06
	2) Excavation, underground	m³	25,300	22.6	813,600	113.0	571,780	20,584,080,000	2.86
	3) Rock support, 20% of 2)	-	LS				400,246	1,543,806,000	0.57
	4) Tunnel support steel ribs (H100@750)	t	470	800.0	28,800,000	4,000.0	376,000	13,536,000,000	1.88
	5) Concrete open structures	m³	1,100	30.0	1,080,000	150.0	33,000	1,188,000,000	0.17
	6) Concrete lining	m³	5,500	51.0	1,071,000	170.0	280,500	5,890,500,000	0.94
	7) Re-bar	t	180	6	15,828,792	1,764.8	1,080	2,849,182,560	0.32
	8) Miscellaneous, 20% of 1) to 7)	-	LS				0	12,223,978,512	1.36
	Subtotal I.2						1,696,806	58,072,617,072	8.15
I.3	Intermediate pond (Water surface area 12 ha)								
	1) Excavation, structural foundation	m³	148,000	3.6	27,060	6.6	532,800	4,004,880,000	0.98
	2) Dike embankment, rockfill with blanket	m³	327,000	1.1	91,065	11.2	359,700	29,778,255,000	3.67
	3) Foundation seepage cutoff sheetpile	t	560	700.0	25,200,000	3,500.0	392,000	14,112,000,000	1.96
	4) Slope stabilize horizontal drain holes	m	14,000	7.0	567,000	70.0	98,000	7,938,000,000	0.98
	5) Concrete, open structure	m³	8,600	30.0	1,080,000	150.0	258,000	9,288,000,000	1.29
	6) Re-bar	t	470	6	15,828,792	1,764.8	2,820	7,439,532,240	0.83
	7) Miscellaneous, 15% of 1) to 6)	-	LS				0	13,102,582,086	1.46
	Subtotal I.3						1,643,320	85,663,249,326	11.16
I.4	Headrace Tunnel (D3.9m, L3,980m), Work Adit (L300mx2) & Surge Tank (D8.5m)								
	1) Excavation, open	m³	8,600	3.6	27,060	6.6	30,960	232,716,000	0.06
	2) Excavation, underground	m³	87,000	22.6	813,600	113.0	1,966,200	70,783,200,000	9.83
	3) Excavation, shaft	m³	5,100	51.0	1,071,000	170.0	260,100	5,462,100,000	0.87
	4) Rock support, 20% of 2)+3)	-	LS				1,497,720	5,776,920,000	2.14
	5) Concrete, open structures	m³	2,500	30.0	1,080,000	150.0	75,000	2,700,000,000	0.38
	6) Concrete lining	m³	32,400	51.0	1,071,000	170.0	1,652,400	34,700,400,000	5.51
	7) Re-bar	t	1,080	6	15,828,792	1,764.8	6,480	17,095,095,360	1.91
	8) Consolidation grouting	m	28,500	13.5	283,500	45.0	384,750	8,079,750,000	1.28
	9) Miscellaneous, 20% of 1) to 8)	-	LS				0	39,538,534,272	4.39
	Subtotal I.4						5,873,610	184,368,715,632	26.36
I.5	Penstock Line, underground (L615m)								
	1) Excavation, open penstock	m³	8,600	3.6	27,060	6.6	30,960	232,716,000	0.06
	2) Excavation, horizontal tunnel	m³	6,900	22.6	813,600	113.0	155,940	5,613,840,000	0.78
	3) Excavation, inclined shaft	m³	5,800	51.0	1,071,000	170.0	295,800	6,211,800,000	0.99
	4) Concrete, encasement	m³	6,300	40.0	1,080,000	160.0	252,000	6,804,000,000	1.01
	5) Re-bar	t	160	6	15,828,792	1,764.8	960	2,532,606,720	0.28
	6) Miscellaneous, 20% of 1) to 5)	-	LS				0	5,603,180,544	0.62
	Subtotal I.5						735,660	26,998,143,264	3.74
I.6	Powerhouse, above ground								
	1) Excavation, open powerhouse	m³	63,000	3.6	27,060	6.6	226,800	1,704,780,000	0.42
	2) Earth backfill	m³	8,500	4.0	16,280	5.8	34,000	138,380,000	0.05
	3) Concrete powerhouse	m³	9,300	30.0	1,080,000	150.0	279,000	10,044,000,000	1.40
	4) Re-bar	t	650	6	15,828,792	31.1	3,900	10,288,714,800	1.15
	5) Architectural finish & utility, 25% of PH	-	LS				0	6,767,293,700	0.75
	6) Miscellaneous, 15% of 1) to 5)	-	LS				0	5,075,470,275	0.56
	Subtotal I.6						543,700	34,018,638,775	4.32
	Subtotal I.1 to I.6						12,430,960	459,064,053,919	63.44
I.7	Environmental mitigation cost during Construction, 1% of Subtotal I.1 to I.6	-	LS				124,310	4,590,640,539	0.63
	Subtotal I.7						124,310	4,590,640,539	0.63
	Subtotal I (I.1 to I.7)						12,555,269	463,654,694,458	64.07
II	STEEL & HYDRO-MECHANICAL WORKS								
	1) Sand flushing gate, 5mx4m, 1no.	t	30	4,900.0	18,900,000	7,000.0	147,000	567,000,000	0.21
	2) Sand flushing stoplog, 5mx4m, 1 no.	t	20	4,200.0	16,200,000	6,000.0	84,000	324,000,000	0.12
	3) River outlet slide valves, D0.5m, 2 nos.	-	LS				42,000	162,000,000	0.06
	4) Intake trashrack	t	16	3,500.0	13,500,000	5,000.0	56,000	216,000,000	0.08
	5) Intake gate, 2 nos.	t	60	4,900.0	18,900,000	7,000.0	294,000	1,134,000,000	0.42
	6) Intake stoplog, 1 no.	t	30	4,200.0	16,200,000	6,000.0	126,000	486,000,000	0.18
	7) Sand drain gate, 2 nos.	t	6	4,200.0	16,200,000	6,000.0	25,200	97,200,000	0.04
	8) Settling basin, end stoplog	t	38	4,200.0	16,200,000	6,000.0	159,600	615,600,000	0.23
	9) Connection tunnel inlet stoplog gate	t	39	4,900.0	18,900,000	7,000.0	191,100	737,100,000	0.27
	10) Connection tunnel outlet stoplog	t	32	4,200.0	16,200,000	6,000.0	134,400	518,400,000	0.19
	11) Pond river outlet steel pipe, D0.5mx100m	t	12	4,200.0	16,200,000	6,000.0	50,400	194,400,000	0.07
	12) Pond river outlet emergency valve, D0.4m	-	LS				35,000	135,000,000	0.05
	13) Pond river outlet service valve, D0.4m	-	LS				35,000	135,000,000	0.05
	14) Draft tube stoplog, 2 nos.	t	28	4,200.0	16,200,000	6,000.0	117,600	453,600,000	0.17
	15) Penstock pipe, D3.2m	t	1,460	4,200.0	16,200,000	6,000.0	6,132,000	23,652,000,000	8.76
	Subtotal II						7,629,300	29,427,300,000	10.90

III	GENERATING EQUIPMENT								
1	Turbine	lot	1				12,960,000	12,960,000,000	14.40
2	Generator	lot	1				10,080,000	10,080,000,000	11.20
3	Control equipment	lot	1				10,080,000	10,080,000,000	11.20
4	Others	lot	1				7,290,000	7,290,000,000	8.10
	Subtotal III						40,410,000	40,410,000,000	44.90
IV	TRANSMISSION LINE								
1	Transmission line, 150 kV	km	10	41,250	123,750,000	55,000.0	412,500	1,237,500,000	0.55
	Subtotal IV						412,500	1,237,500,000	0.55
	Subtotal, I to IV						61,007,069	534,729,494,458	120.42
V	PREPARATORY WORKS	-	LS				6,100,707	53,472,949,446	12.04
	(10% of Subtotal I to IV)						6,100,707	53,472,949,446	12.04
	Subtotal V						6,100,707	53,472,949,446	12.04
VI	SITE ACCESS								
1	Access roads	km	7.5				0	24,840,000,000	2.76
(1)	AR1, new, existing road and intake	km	0.2	0.0	3,600,000,000	400,000.0	0	720,000,000	0.08
(2)	AR2, improve, existing road - pond	km	1.2	0.0	1,800,000,000	200,000.0	0	2,160,000,000	0.24
(3)	AR3, new, existing road - pond dike	km	1.0	0.0	3,600,000,000	400,000.0	0	3,600,000,000	0.40
(4)	AR4, new, AR3 - headrace tunnel inlet	km	0.8	0.0	3,600,000,000	400,000.0	0	2,880,000,000	0.32
(5)	AR5, new, AR2 - spoil bank 1 and 2	km	0.5	0.0	3,600,000,000	400,000.0	0	1,800,000,000	0.20
(6)	AR6, new, existing road - Simanggo river	km	0.4	0.0	3,600,000,000	400,000.0	0	1,440,000,000	0.16
(7)	AR7, new, AR6 - powerhouse	km	1.3	0.0	3,600,000,000	400,000.0	0	4,680,000,000	0.52
(8)	AR8, new, AR7 - surge tank	km	1.8	0.0	3,600,000,000	400,000.0	0	6,480,000,000	0.72
(9)	AR9, new, AR8 - work adit 1	km	0.3	0.0	3,600,000,000	400,000.0	0	1,080,000,000	0.12
2	Bridge						0	18,900,000,000	2.10
(1)	BR1, new & permanent near intake site	m ²	300	0.0	13,500,000	1,500.0	0	4,050,000,000	0.45
(2)	BR2, new & permanent near pond	m ²	300	0.0	13,500,000	1,500.0	0	4,050,000,000	0.45
(3)	BR3, new & permanent cross Simanggo R.	m ²	500	0.0	13,500,000	1,500.0	0	6,750,000,000	0.75
(4)	BR4, new & permanent near PS site	m ²	300	0.0	13,500,000	1,500.0	0	4,050,000,000	0.45
	Subtotal VI						0	43,740,000,000	4.86
	TOTAL, I to VI						67,107,776	631,942,443,904	137.32
%							49	51	

Table 13.3.2 Summary of Project Costs for Simanggo-2

Item No.	Project Cost Items	Cost total		Total, FC+LC Million US\$
		FC (US\$)	LC (Rp.)	
I	Construction cost			
1	Preparatory works	6,100,707	53,472,949,446	12.0
2	Civil works	12,555,269	463,654,694,458	64.1
3	Hydro-mechanical works	7,629,300	29,427,300,000	10.9
4	Generating equipment	40,410,000	40,410,000,000	44.9
5	Transmission line	412,500	1,237,500,000	0.6
6	Site access roads	0	43,740,000,000	4.9
	Subtotal-1	67,107,776	631,942,443,904	137.3
	Value Added Tax (PPn)	0	123,591,242,978	13.7
	Subtotal-2	67,107,776	755,533,686,882	151.1
II	Land acquisition & resettlement cost	44,000	16,059,800,000	1.8
III	Administration of executing agency	0	61,795,621,489	6.9
IV	Engineering services cost	2,885,000	5,690,000,000	3.5
	Subtotal-3	70,036,776	839,079,108,371	163.3
V	Price contingency	5,228,386	226,559,879,889	30.4
	Subtotal-4	75,265,162	1,065,638,988,260	193.7
VI	Physical contingency	7,003,678	83,907,910,837	16.3
	Grand total	82,268,840	1,149,546,899,097	210.0

Table 13.3.3 Annual Disbursement Schedule for Simanggo-2

Item No.	Disbursement items			Cost Total (mil.)		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
				FC (US\$)	LC (Rp)	2012	2013	2014	2015	2016	2017
	FC portion										
I	Construction Cost			67,107,776		0	0	3,013,243	9,200,380	30,246,798	24,647,356
II	Land Acquisition & Resettlement Cost			44,000		0	35,200	8,800	0	0	0
III	Administration of Executing Agency			0		0	0	0	0	0	0
IV	Engineering Services Cost			2,885,000		419,000	199,500	668,100	599,400	599,400	399,600
	Sub Total - 1			70,036,776		419,000	234,700	3,690,143	9,799,780	30,846,198	25,046,956
V	Price Contingency <1	% p/a	1.3	5,228,386		5,992	6,756	160,374	571,573	2,263,597	2,220,095
	(Base year 2013 of L/A)	=	1								
	Sub Total - 2			75,265,162		424,992	241,456	3,850,517	10,371,353	33,109,794	27,267,051
VI	Physical Contingency <2			7,003,678		41,900	23,470	369,014	979,978	3,084,620	2,504,696
	Total			82,268,840		466,892	264,926	4,219,531	11,351,331	36,194,414	29,771,746
	LC portion										
I	Construction Cost				631,942,443,904	0	0	75,635,078,377	245,953,632,931	259,761,967,775	50,591,764,821
					123,591,242,978	0	0	10,275,426,112	32,875,705,330	53,198,314,654	27,241,796,881
II	Land Acquisition & Resettlement Cost				16,059,800,000	0	12,847,840,000	3,211,960,000	0	0	0
III	Administration of Executing Agency				61,795,621,489	0	0	5,137,713,056	16,437,852,665	26,599,157,327	13,620,898,441
IV	Engineering Services Cost				5,690,000,000	600,000,000	205,000,000	1,141,000,000	1,404,000,000	1,404,000,000	936,000,000
	Sub Total - 1				839,079,108,371	600,000,000	13,052,840,000	95,401,177,545	296,671,190,926	340,963,439,756	92,390,460,143
V	Price Contingency <1	% p/a	5.0		226,559,879,889	33,000,000	1,471,707,710	16,541,371,672	70,327,945,423	103,622,103,080	34,563,752,003
	(Base year 2013 of L/A)	=	1								
	Sub Total - 2				1,065,638,988,259	633,000,000	14,524,547,710	111,942,549,217	366,999,136,349	444,585,542,837	126,954,212,146
VI	Physical Contingency <2				83,907,910,837	60,000,000	1,305,284,000	9,540,117,755	29,667,119,093	34,096,343,976	9,239,046,014
	Total				1,149,546,899,096	693,000,000	15,829,831,710	121,482,666,971	396,666,255,442	478,681,886,812	136,193,258,161
	Total FC+LC equivalent US\$ mil.				210.0	0.5	2.0	17.7	55.4	89.4	44.9

Notes <1 1.3% for FC and 5.0% for LC per annum
 <2 10% of subtotal - 2

CHAPTER 14 JUSTIFICATION OF THE PROJECT

14.1 INTRODUCTION TO JUSTIFICATION

Justification of the project in this chapter appraises the profit of an investment through two analyses; the economic analysis and financial analysis. The economic analysis measures the effect of the questioned project on the national economy, whereas the financial analysis estimates the profit accruing to the project-operating entity. For the project to be feasible, it must be economically efficient, as well as financially sustainable.

Both of the economic and financial analyses are conducted in monetary terms, by using the Discounted Cash Flow (DCF) models. The major difference lies in the definition of the respective costs and benefits. In the economic analysis, overall impact of the project is considered for the economic welfare of the citizens of the country. In the financial analysis, by contrast, all expenditures to be incurred under the project and revenues resulting from it are taken into account.

14.2 ECONOMIC EVALUATION

14.2.1 METHODOLOGY

The economic evaluation is to compare two different electricity; one generated from the questioned hydropower project and the other supplied by possible power plants (the alternative plant). The idea is that the hydropower should be chosen for electricity supply to the system, only when its generation cost is evaluated more economical than any other possible alternative plants. The practical types of the alternative plants are three thermal plants in the country. They are i) coal fired steam plants, which can generate base load electricity only, ii) gas turbines using natural gas, which can generate any pattern of electricity in a single day, and iii) gas turbines using high speed diesel (HSD), which also can generate any pattern of electricity.

The questioned hydropower scheme has been optimized to be a 90 MW of run-of-river equipped with a daily peak generation capability. It will generate every day 36.3 MW of the base load in average and additional 53.7 MW of the 5-hour peak load. Its typical daily generation pattern looks like Figure 14.2.1. This generation pattern can be equalized with a combination of two alternative plants; one 45.4 MW¹ base load plant plus one 60.4 MW peak load plant. As compared in Table 14.2.1, the coal fired

¹ The installed capacity of an alternative plant is not equal to that of the hydropower, because of differences of efficiencies. See "Economic Benefit" discussed later in this chapter.

plant is the cheapest in generation cost and is chosen as the alternative plant for base load. Very similarly, as compared in Table 14.2.2, the gas turbine using natural gas is selected as the alternative plant for peak load. Note that these alternative plants are virtual machines and do not necessarily have to have exact installed capacities of 45.4 MW and 60.4 MW.

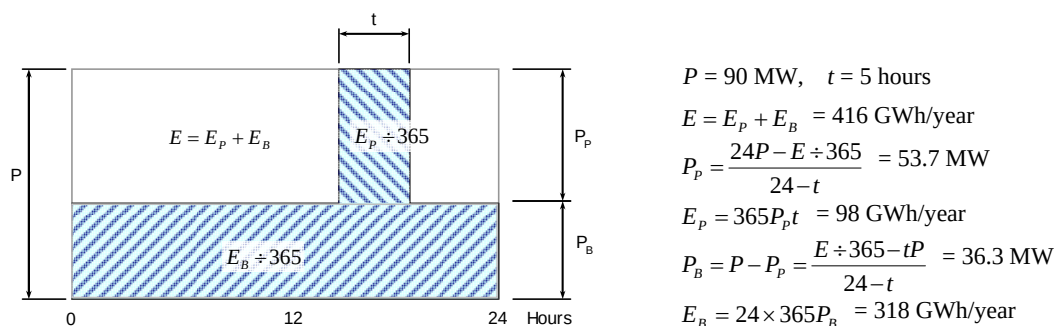


Figure 14.2.1 Typical Daily Generation Pattern Planned for Simanggo-2 Hydropower Project

Table 14.2.1 Generation Costs of Base Load Plants

Descriptions	Unit	Natural Gas	Coal Fired
1. Unit Construction Cost	US\$/kW	600	1,300
2. Construction Period	Yrs	2	2
3. Disbursement		40%, 60%	40%, 60%
4. Project Life	Yrs	20	20
5. Annual Fixed O&M Cost Ratio		2.5%	2.0%
6. Capacity Cost	US\$/Year	79.01	165.38
7. Fuel Price	US\$/MMBtu	6.000	3.459
8. Thermal Efficiency		0.260	0.300
9. Fuel Consumption	MMBTU/kWh	0.013	0.011
10. Unit Cost of Fuel	US\$/kWh	0.079	0.039
11. Losses		0.020	0.090
	Station Use Loss	0.010	0.070
	Transmission Line Loss	0.010	0.020
	Forced Outage	0.070	0.080
	Scheduled Outage	0.100	0.120
12. Plant Factor*		98.00%	91.00%
13. Unit Generation Cost	US¢/kWh	8.795	6.009

* The theoretical maximum value is assumed.

10% discount rate.

Source: Study Team based on RUPTL 2010-19, PLN

Table 14.2.2 Generation Costs of Peak Load Plants

Descriptions	Unit	Natural Gas	HSD
1. Unit Construction Cost	US\$/kW	600	550
2. Construction Period	Yrs	2	2
3. Disbursement		40%, 60%	40%, 60%
4. Project Life	Yrs	20	20
5. Annual Fixed O&M Cost Ratio		2.5%	2.5%
6. Capacity Cost	US\$/Year	79.01	72.43
7. Fuel Price	US\$/MMBtu	14.448	14.448
8. Thermal Efficiency		0.260	0.310

	Descriptions	Unit	Natural Gas	HSD
9.	Fuel Consumption	MMBTU/kWh	0.013	0.011
10.	Unit Cost of Fuel	US\$/kWh	0.079	0.159
11.	Losses		0.020	0.020
	Station Use Loss		0.010	0.010
	Transmission Line Loss		0.010	0.010
	Forced Outage		0.070	0.070
	Scheduled Outage		0.100	0.100
12.	Plant Factor*		25.00%	25.00%
13.	Unit Generation Cost	US¢/kWh	11.482	19.210

* 6 hour daily peak load generation is assumed.

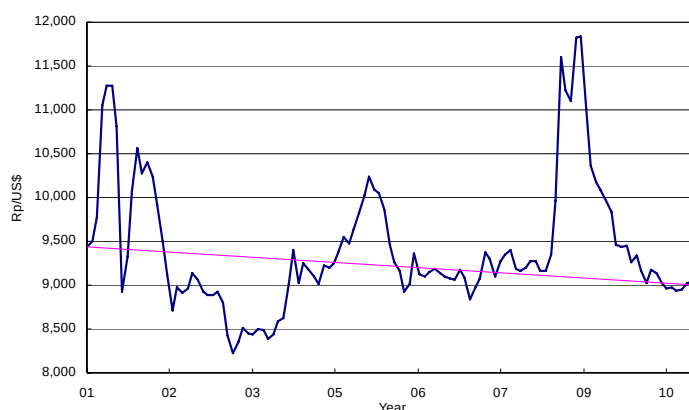
10% discount rate.

Source: Study Team based on RUPTL 2010-19, PLN

14.2.2 BASIC ASSUMPTIONS IN ECONOMIC ANALYSIS

In the economic analysis, the following assumptions were made:

- (1) The evaluation period is 54 years, being composed of 4 years of construction and 50 years of operation.
- (2) The useful life of the civil components is 50 years, same as the period of operation. The life of the non-civil components, such as hydro-electrical works and transmission line, etc., is 30 years. After 30 years, all of the non-civil components are renewed. No residual values are considered.
- (3) All costs and benefits are expressed in constant US Dollars at 2011 price level. Any future change in the general price level is ignored. The exchange rate used is Rp. 9,000/US\$, which is an estimation for year 2011 based on the past trend as illustrated in Figure 14.2.2.
- (4) 10% p.a. of a discount rate is assumed in the economic analysis. This assumption focuses on the economic rate of return on alternative marginal projects or the economic opportunity cost of capital, so that investments can be selected that show a minimum rate of return that is not exceeded by other possible investments.



Source: PACIFIC Exchange Rate Service

Figure 14.2.2 Historical Exchange Rate

14.2.3 ECONOMIC COST

14.2.3.1 Capital Expenditure

The economic cost comes from the financial cost, but is not equal. The economic analysis attempts to value the costs from national economic perspective. To achieve this, some adjustments and deletions should be made to the financial prices to account for the effects of the government intervention and market structure. Using world price numeraire, standard conversion factor = 0.90, the following financial-to-economic conversions are ruled in this economic analysis.

Table 14.2.3 Financial to Economic Conversions

Financial	FC	LC	Total	Economic	FC	LC	Total
Feasibility study	0.44	0.07	0.51	Feasibility study	0.00	0.00	0.00
Civil Works	18.66	62.32	80.97	Civil Works	18.66	56.09	74.74
Generating Equipment	40.41	4.49	44.90	Generating Equipment	40.41	4.04	44.45
Other Construction	8.04	3.41	11.45	Other Construction	8.04	3.07	11.11
VAT	0.00	13.73	13.73	VAT	0.00	0.00	0.00
Land acquisition	0.04	1.78	1.83	Land acquisition	0.04	1.61	1.65
Administration	0.00	6.87	6.87	Administration	0.00	0.00	0.00
Engineering	2.47	0.57	3.03	Engineering	2.47	0.51	2.98
Contingency	6.96	9.32	16.28	Contingency	6.96	6.53	13.49
Price Escalation	5.22	25.17	30.39	Price Escalation	0.00	0.00	0.00
Total	82.24	127.72	209.96	Total	76.58	71.84	148.42
	39%	61%	100%		52%	48%	100%

Conversion Factor	FC	LC	Average
Feasibility study	0.00	0.00	0.00
Civil Works	1.00	0.90	0.92
Generating Equipment	1.00	0.90	0.99
Other Construction	1.00	0.90	0.97
VAT	0.00	0.00	0.00
Land Acquisition	1.00	0.90	0.90
Administration	0.00	0.00	0.00
Engineering	1.00	0.90	0.98
Contingency	1.00	0.70	0.83
Price Escalation	0.00	0.00	0.00
Total	0.93	0.56	0.71

Excluded from financial CAPEX

Unit US\$ million

VAT & Administration excluded from Contingency

FC: foreign currency, LC: local currency

Source: Study Team

Here, any sunk costs, which might have been incurred before implementation, are excluded from the capital expenditure (CAPEX). The administration cost is converted nil, because it will be incurred regardless of the project development. The price contingency is also nil, because escalation effects are beyond the scope of the economic analysis.

The economic CAPEX is assumed to be disbursed during four years of construction with the yearly disbursement ratios; 20%, 35%, 35%, and 10%.

14.2.3.2 Operating Expenditure

In the economic analysis, the operating expenditure (OPEX) is also expressed in the economic terms. There are three kinds; i) fixed operating cost, which will be incurred no matter how much electricity is generated, ii) variable operating cost, which will be burdened proportionally to electricity actually generated, and iii) major maintenance cost, which will cost periodically for replacing or overhauling aged machines.

(1) Fixed Operating Cost

The fixed operating cost is composed of costs required for daily operation, maintenance, and management. From the past experience, its yearly cost is assumed to be 0.5% of the civil portion plus 1.5% of the non-civil portion of CAPEX.

(2) Variable Operating Cost

The variable operating cost includes water charges, which is Rp. 5.0 per kWh of electricity levied by the regional government.

(3) Major Maintenance Cost

The major maintenance cost substantially consists of replacement cost of non-civil components, mainly hydro-mechanical and electrical equipment. It is expected to be scheduled every 30 years after the equipment has been installed or replaced. One year period is estimated for such replacement.

14.2.4 ECONOMIC BENEFIT

14.2.4.1 Concept of Economic Benefit

If the questioned hydropower project is not developed, alternative electricity (generated by the alternative plants) needs to be supplied to meet the increasing demand. The economic benefit can lie on an evasion of the opportunity cost of such alternative electricity, which can be defined as the capacity benefit and the energy benefit.

14.2.4.2 Capacity Benefit

The capacity benefit is the opportunity cost required for the alternative plants being ready to generate electricity as demanded.

Hydropower units are different from the alternative plants in terms of performances. Hydropower units consume less energy than thermal plants do and therefore their station loss of electricity is less than that of thermal plants. However, hydropower units are in general located remote and farther from the demand center and therefore their transmission loss is greater. As a result, usable electricity generated by a hydropower plant and that by a thermal power plant are different, even if they have an identical installed capacity. To adjust the difference, one needs to introduce the

power (or kW) adjustment factor. That is:

$$\begin{aligned}
 \text{kW adjustment factor} &= \frac{s_H \times a_H \times m_H \times t_H}{s_A \times a_A \times m_A \times t_A} \\
 &= \frac{0.997 \times 0.995 \times 0.980 \times 0.950}{0.930 \times 0.920 \times 0.880 \times 0.980} = 1.252 \text{ for coal fired plants} \\
 &= \frac{0.997 \times 0.995 \times 0.980 \times 0.950}{0.990 \times 0.930 \times 0.900 \times 0.990} = 1.126 \text{ for gas turbines using} \\
 &\quad \text{natural gas}
 \end{aligned}$$

where s_x : station factor = 1 – station loss
 a_x : availability factor = 1 – forced outage loss
 m_x : maintenance factor = 1 – schedule outage loss
 t_x : transmission factor = 1 – transmission line loss
 x : $_H$ for hydropower, $_A$ for alternative thermal plant

The 36.3 MW of the base power generation capacity of the questioned hydropower is equalized to be 45.4 MW (36.3 MW x 1.252) of a coal fired power plant, while the 53.7 MW of the peak power generation capacity of the same is equalized to be 60.5 MW (53.7 MW x 1.126) of a gas turbine using natural gas.

14.2.4.3 Energy Benefit

The energy benefit is the opportunity cost required for generating electricity by using the alternative plants.

As discussed earlier, because of different characteristics, usable amount out of 1 kWh electricity generated by a hydropower plant and by a thermal plant is not equal. To adjust the difference, the energy (or kWh) adjustment factor need be introduced. That is:

$$\begin{aligned}
 \text{kWh adjustment factor} &= \frac{s_H \times t_H}{s_A \times t_A} \\
 &= \frac{0.997 \times 0.950}{0.930 \times 0.980} = 1.039 \text{ for coal fired plants} \\
 &= \frac{0.997 \times 0.950}{0.990 \times 0.990} = 0.966 \text{ for gas turbines using natural gas}
 \end{aligned}$$

The 318 GWh of the base power energy by the questioned hydropower is then equalized to be 330 GWh (318 GWh x 1.039) by a coal fired power plant, while the 98 GWh of the peak energy by the same is to be 95 GWh (98 GW x 0.966) of a gas turbine using natural gas.

14.2.4.4 Depletion Premium

Alternative thermal plants involve exploitation of fossil fuels. They are the depletable resources, which initially exist in the form of deposits and their use leads to a decline in them. The economic analysis needs to explicitly include the depletion premium as one of the economic benefits. The depletion premium can be defined as:

$$D_t = \frac{(P_T - C_t)(1+r)^t}{(1+r)^T}$$

where D_t = depletion premium at time t ,
 P_T = price of substitute at the time of complete exhaustion T ,
 C_t = extraction cost of present resource, assumed to be constant for all years,
 r = discount rate, and
 T = time of exhaustion of deposit.

The prices of natural gas and HSD given in Table 14.2.1 and Table 14.2.2 can be recognized as to a level of the respective international prices, because Indonesia has been a net importer for both of the fossil fuels. No depletion premiums need be discussed for natural gas and HSD. By contrast, the coal price in Table 14.2.1 has not reached a level of the international price. Therefore, one should value the depletion premium of coal.

According to JCOAL, Japan, the mineable coal reserve in Indonesia is estimated to be 18.7 billion tons as of 2008, while the annual coal production is 366 million tons per year. These numbers imply that the Indonesian coal may be depleted in 51 years. Upon depletion, imported coal is the most likely substitute for the Indonesian coal, as if Japan experienced decades ago. Assuming that the present coal price (or extraction cost) of the Indonesian coal is US\$70/ton and the Japanese CIF coal price is US\$83.3/ton², the depletion premium of coal is evaluated to be US\$0.103/ton at present and US\$13.300/ton, when Indonesian coal has been fully depleted. The values used for the depletion premium are given in Table 14.2.4.

Table 14.2.4 Values for Depletion Premium

Size of deposits	18,700.00	million ton
Extraction rate	365.61	million ton
Life of deposit to exhaustion	51.15	years
Present extraction costs	70.00	US\$/ton
Calorific value	5,100	kcal/kg
Substitute fuel	Imported Coal	
Present price of substitute fuel	83.30	US\$/ton
Price of substitute fuel at exhaustion	83.30	US\$/ton
Discount rate used	0.10	p.a.

Source: Study Team

The coal price including the depletion premium was then estimated as illustrated in Figure 14.2.3. Note that the price escalation in nominal terms of future coal is estimated very gentle, as illustrated in Figure 14.2.4. This economic analysis therefore assumes that the future international coal price will be substantially equal to the present price.

Despite the analysis above, the depletion premium is not taken into account of the base case of the economic analysis. This is not only because the premium computed is marginal but because most of the past hydropower feasibility studies do not contain discussions of the depletion premium and the economic profitability of the project might mislead the readers. Instead, the

² According to the trading database of Ministry of Finance, Japan (http://toukei-is.com/get_pdf/?p=30101&f=00), the latest CIF of the thermal coal is JPY9,520/ton, US\$114/ton equivalent. Because the Japan's thermal coal has typically 7,000 kcal/kg of the calorific value, the CIF can be converted to be US\$83.3/ton with 5,100 kcal/kg of the calorific value.

depletion premium discussed here is taken into account of the sensitivity analysis later in this section.

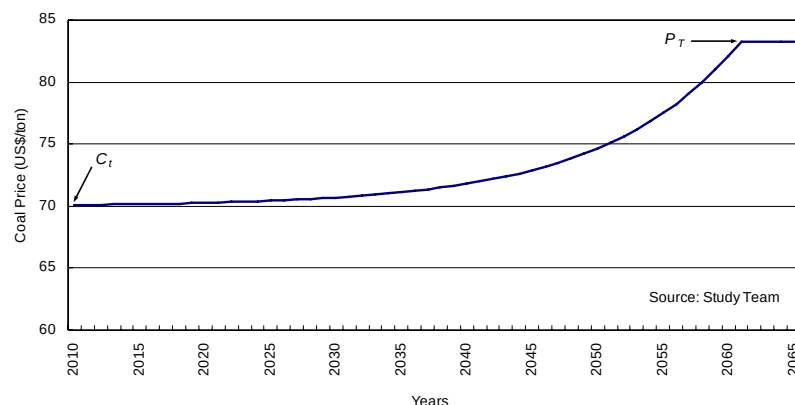


Figure 14.2.3 Coal Price with Depletion Premium

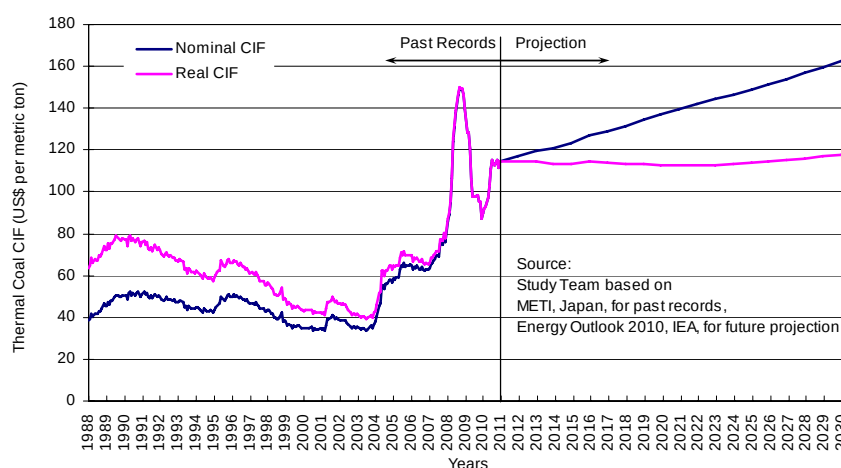


Figure 14.2.4 Coal Price Projection by IEA Energy Outlook 2010

14.2.4.5 Benefit from Certified Emission Reduction

The CDM (clean development mechanism) may be adopted to the project. Therefore, benefits from the Certified Emission Reduction (CER) are also considered.

$$\text{CO}_2 \text{ emission factor} = 0.743 \text{ tCO}_2/\text{MWh}^3$$

$$\text{Expected CER price} = 12.5 \text{ US}\$/\text{tCO}_2$$

$$\begin{aligned} \text{Possible CER Benefit} &= \text{Effective Electricity Generated} \times \text{CO}_2 \text{ emission factor} \times \text{CER price} \\ &= 384 \text{ GWh/year} \times 0.743 \text{ tCO}_2/\text{MWh} \times 12.5 \text{ US}\$/\text{tCO}_2 \\ &= 3.57 \text{ US}\$/\text{M/year} \end{aligned}$$

The CER benefit is counted in the sensitivity analysis for the base case + CDM.

³ Based on DNA Indonesia
http://dna-cdm.menlh.go.id/Downloads/Others/KomnasMPB_Grid_Sumatera_JAMALI_2008.pdf

14.2.5 ECONOMIC ANALYSIS

For the economic analysis, three measures of project worth are introduced as the key indicators; the net present value (ENPV), the economic internal rate of return (EIRR), and the benefit-cost ratio (B/C). These three measures are calculated with the economic costs and benefits as variables.

A DCF based economic stream is built as tabulated in Table 14.2.6. The key indicators show sufficient economic feasibility:

$$\begin{aligned} \text{ENPV} &= \text{US\$117.9 mill.} \quad \text{EIRR} = 21.8\% \\ \text{B/C} &= 1.83 \end{aligned}$$

14.2.6 ECONOMIC SENSITIVITY

A sensitivity analysis was conducted to examine the extent to which the economic indicators change for different values of the major variables. In this economic analysis, 5 cases were tested, namely, + Depletion Premium, + CDM, – 10% Annual Energy, + 10% CAPEX & OPEX, and – 10% Fuel Prices.

The sensitivity analysis has confirmed that the hydropower project in question economically feasible, as summarized in Table 14.2.5.

Table 14.2.5 Economic Indicators

Cases	B/C	ENPV	EIRR	Notes
Base Case	1.83	117.9	21.8%	the base case
+ Depletion Premium	1.84	118.9	21.8%	depletion premium added to the base case
+ CDM	2.02	144.5	23.9%	CER benefit added to the base case
– 10% Annual Energy	1.61	86.5	18.4%	less hydropower generation by 10%
+ 10% CAPEX & OPEX	1.67	103.8	19.2%	greater cost by 10%
– 10% Fuel Prices	1.72	102.7	20.5%	Fuel cost is less expensive by 10%

Source: Study Team

Table 14.2.6 DCF Based Economic Stream of Base Case**Economic Analysis (Base Case) Simanggo-2****1. Hydro General**

Discount Rate	<i>i</i>	10%
Construction Time	years	4
Life Time, Civil	years	50
Life Time, Non Civil	years	30
Evaluation Time	years	54
Installed Capacity	MW	90
Annual Energy	GWh	416
Peaking Time	hours	5
Station Use Loss	<i>a</i>	0.003
Transmission Line Loss	<i>b</i>	0.050
Forced Outage	<i>c</i>	0.005
Scheduled Outage	<i>d</i>	0.020
Implementation Cost, total	US\$M	148.420
Implementation Cost, civil	US\$M	82.217
Implementation Cost, non civil	US\$M	48.896
Implementation Cost, others	US\$M	17.307
Annual O&M Cost Ratio, civil		0.50%
Annual O&M Cost Ratio, non civil		1.50%
Annual O&M Cost	US\$/yr	1.145
CER Emission Coeff.	tCO ₂ /MWh	0.743
CER Unit Price	US\$/CO ₂ -ton	0.000
Annual CER	US\$/yr	0.000

2. Alternative Thermal, Gas Turbine for Peak

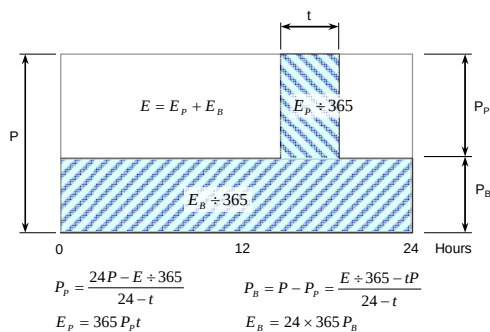
Installed Capacity	<i>P_p</i> MW	53.699
Unit Construction Cost	US\$/kW	600
Construction Time	years	2
Life Time	years	20
Annual Fixed O&M Cost Ratio		2.50%
Replacement Cost Ratio		90%
kW Value Adjustment Factor		1.126
Capacity Value	US\$/kW	74.490
Capacity Benefit	US\$M	36.273
Fixed O&M Benefit	US\$/yr	0.907
Annual Energy	<i>E_p</i> GWh	98.000
Station Use Loss	<i>a</i>	0.010
Transmission Line Loss	<i>b</i>	0.010
Forced Outage	<i>c</i>	0.070
Scheduled Outage	<i>d</i>	0.100
Unit Price of Natural Gas	US\$/MMBTU	6
Caloric Value	kcal/MMBTU	252,000
Thermal Efficiency		26%
Heat Rate	kcal/MMBTU	3,308
Fuel Consumption	MMBTU/kWh	0.0131
Fuel Cost	US\$/kWh	0.0788
Variable O&M Cost	US\$/kWh	0.0040
kWh Value Adjustment Factor		0.9664
Energy Value	US\$/kWh	0.0800
Energy Benefit	US\$M	7.8373

3. Alternative Thermal, Coal-Fired for Off Peak

Installed Capacity	<i>P_B</i> MW	36.30
Unit Construction Cost	US\$/kW	1,300
Construction Time	years	2
Life Time	years	20
Annual Fixed O&M Cost Ratio		2.0%
Replacement Cost Ratio		90%
kW Value Adjustment Factor		1.252
Capacity Value	US\$/kW	173.339
Capacity Benefit	US\$M	59.068
Fixed O&M Benefit	US\$/yr	1.181
Annual Energy	<i>E_B</i> GWh	318.000
Station Use Loss	<i>a</i>	0.070
Transmission Line Loss	<i>b</i>	0.020
Forced Outage	<i>c</i>	0.080
Scheduled Outage	<i>d</i>	0.120
Unit Price of Coal	US\$/ton	70
Caloric Value	kcal/kg	5,100
Thermal Efficiency		30%
Heat Rate	kcal/kWh	2,867
Fuel Consumption	kg/kWh	0.5621
Fuel Cost	US\$/kWh	0.0393
Variable O&M Cost	US\$/kWh	0.0008
kWh Value Adjustment Factor		1.0392
Energy Value	US\$/kWh	0.0417
Energy Benefit	US\$M	13.2673

4. Economic Indicators

B/C = 1.83
 ENPV = US\$117.9 mill.
 EIRR = 21.8%

**Cash Flow**

Year	Capacity		Energy		CER	Total Benefit	Hydro Cost			Net
	Peak	Base	Peak	Base			Capital	O&M	Total	
0	0.00	0.00	0.00	0.00	0.00	0.00	29.68	0.00	29.68	-29.68
1	0.00	0.00	0.00	0.00	0.00	0.00	51.95	0.00	51.95	-51.95
2	18.14	29.53	0.00	0.00	0.00	47.67	51.95	0.00	51.95	-4.28
3	18.14	29.53	0.00	0.00	0.00	47.67	14.84	0.00	14.84	32.83
4	0.91	1.18	7.84	13.27	0.00	23.19	0.00	1.14	1.14	22.05
5	0.91	1.18	7.84	13.27	0.00	23.19	0.00	1.14	1.14	22.05
6	0.91	1.18	7.84	13.27	0.00	23.19	0.00	1.14	1.14	22.05
7	0.91	1.18	7.84	13.27	0.00	23.19	0.00	1.14	1.14	22.05
8	0.91	1.18	7.84	13.27	0.00	23.19	0.00	1.14	1.14	22.05
9	0.91	1.18	7.84	13.27	0.00	23.19	0.00	1.14	1.14	22.05
10	0.91	1.18	7.84	13.27	0.00	23.19	0.00	1.14	1.14	22.05
11	0.91	1.18	7.84	13.27	0.00	23.19	0.00	1.14	1.14	22.05
12	0.91	1.18	7.84	13.27	0.00	23.19	0.00	1.14	1.14	22.05
13	0.91	1.18	7.84	13.27	0.00	23.19	0.00	1.14	1.14	22.05
14	0.91	1.18	7.84	13.27	0.00	23.19	0.00	1.14	1.14	22.05
15	0.91	1.18	7.84	13.27	0.00	23.19	0.00	1.14	1.14	22.05
16	0.91	1.18	7.84	13.27	0.00	23.19	0.00	1.14	1.14	22.05
17	0.91	1.18	7.84	13.27	0.00	23.19	0.00	1.14	1.14	22.05
18	0.91	1.18	7.84	13.27	0.00	23.19	0.00	1.14	1.14	22.05
19	0.91	1.18	7.84	13.27	0.00	23.19	0.00	1.14	1.14	22.05
20	0.91	1.18	7.84	13.27	0.00	23.19	0.00	1.14	1.14	22.05
21	0.91	1.18	7.84	13.27	0.00	23.19	0.00	1.14	1.14	22.05
22	17.23	27.76	7.84	13.27	0.00	66.10	0.00	1.14	1.14	64.95
23	17.23	27.76	7.84	13.27	0.00	66.10	0.00	1.14	1.14	64.95
24	0.91	1.18	7.84	13.27	0.00	23.19	0.00	1.14	1.14	22.05
25	0.91	1.18	7.84	13.27	0.00	23.19	0.00	1.14	1.14	22.05
26	0.91	1.18	7.84	13.27	0.00	23.19	0.00	1.14	1.14	22.05
27	0.91	1.18	7.84	13.27	0.00	23.19	0.00	1.14	1.14	22.05
28	0.91	1.18	7.84	13.27	0.00	23.19	0.00	1.14	1.14	22.05
29	0.91	1.18	7.84	13.27	0.00	23.19	0.00	1.14	1.14	22.05
30	0.91	1.18	7.84	13.27	0.00	23.19	0.00	1.14	1.14	22.05
31	0.91	1.18	7.84	13.27	0.00	23.19	0.00	1.14	1.14	22.05
32	0.91	1.18	7.84	13.27	0.00	23.19	0.00	1.14	1.14	22.05
33	0.91	1.18	7.84	13.27	0.00	23.19	48.90	1.14	50.04	-26.85
34	0.91	1.18	7.84	13.27	0.00	23.19	0.00	1.14	1.14	22.05
35	0.91	1.18	7.84	13.27	0.00	23.19	0.00	1.14	1.14	22.05
36	0.91	1.18	7.84	13.27	0.00	23.19	0.00	1.14	1.14	22.05
37	0.91	1.18	7.84	13.27	0.00	23.19	0.00	1.14	1.14	22.05
38	0.91	1.18	7.84	13.27	0.00	23.19	0.00	1.14	1.14	22.05
39	0.91	1.18	7.84	13.27	0.00	23.19	0.00	1.14	1.14	22.05
40	0.91	1.18	7.84	13.27	0.00	23.19	0.00	1.14	1.14	22.05
41	0.91	1.18	7.84	13.27	0.00	23.19	0.00	1.14	1.14	22.05
42	17.23	27.76	7.84	13.27	0.00	66.10	0.00	1.14	1.14	64.95
43	17.23	27.76	7.84	13.27	0.00	66.10	0.00	1.14	1.14	64.95
44	0.91	1.18	7.84	13.27	0.00	23.19	0.00	1.14	1.14	22.05
45	0.91	1.18	7.84	13.27	0.00	23.19	0.00	1.14	1.14	22.05
46	0.91	1.18	7.84	13.27	0.00	23.19	0.00	1.14	1.14	22.05
47	0.91	1.18	7.84	13.27	0.00	23.19	0.00	1.14	1.14	22.05
48	0.91	1.18	7.84	13.27	0.00	23.19	0.00	1.14	1.14	22.05
49	0.91	1.18	7.84	13.27	0.00	23.19	0.00	1.14	1.14	22.05
50	0.91	1.18	7.84	13.27	0.00	23.19	0.00	1.14	1.14	22.05
51	0.91	1.18	7.84	13.27	0.00	23.19	0.00	1.14	1.14	22.05
52	0.91	1.18	7.84	13.27	0.00	23.19	0.00	1.14	1.14	22.05
53	0.91	1.18	7.84	13.27	0.00	23.19	0.00	1.14	1.14	22.05
54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Σ	146.91	224.46	391.87	663.37	0.00	1426.6	197.32	57.23	254.54	1172.06
NPV	39.77	62.56	58.38	98.83	0.00	259.5	133.10	8.53	141.62	117.92
Ann	4.00	6.29	5.87	9.94	0.00	26.11	13.39	0.86	14.25	11.86

Capacity in MW, Energy in GWh, Cost & Benefit in US\$ mill.

14.3 FINANCIAL EVALUATION

14.3.1 METHODOLOGY

The goal of the financial evaluation is to estimate the attractiveness of the investment opportunity. A DCF model is used, which provides future free cash flow projections and discounts them to arrive at a present value. If the value arrived at through the DCF model is higher than the current cost of the investment, the opportunity may be a good one. There are two major indicators generated from the DCF model; a financial net present value (NPV_p) and a financial internal rate of return (FIRR). On one hand, NPV_p shows the value of a financial stream of future cash flows discounted back to the present. FIRR, on the other hand, computes a break-even rate of return, which equates the cash outflows and the cash inflows.

BOX 1 Financial Rates of Return

The financial rate of return may be different depending on which cost or expense is concerned. In this financial analysis two financial rates are focused; FIRR (financial internal rate of return) and ROI (return on investment). FIRR is concerned with an entire project. By contrast, ROI measures a return to capital holders.

FIRR = an internal rate of return on the overall project expenditure in financial terms before financing charges
= discount rate that makes $NPV_p = 0$.

NPV_p = a net present value in financial terms of the overall project's return without financing charges

ROI = a return on investment in financial terms
= discount rate that makes $NPV_i = 0$.

NPV_i = a net present value in financial terms of the investment

ROE = a return on equity in financial terms
= discount rate that makes $NPV_E = 0$.

NPV_E = a net present value in financial terms of the equity investment

14.3.2 BASIC ASSUMPTIONS IN FINANCIAL ANALYSIS

14.3.2.1 Evaluation Period

The evaluation period is 55 years, being composed of 1 year of leading time, 4 years of construction and 50 years of operation. Construction starts in 2014 and operation starts in end 2017.

14.3.2.2 Currency and Exchange Rate

The dollar of the United State of America (USD) is used in the analysis. The exchange rate between Indonesian Rupiah and USD is Rp. 9,000/USD.

14.3.2.3 Price Escalation

The financial analysis focuses the foreign items on the recent core price index of OECD member countries. It is a price index excluding volatile prices such as foods. As the latest core price index is 1.3% p.a., the price escalation rate for the foreign currency cost portion of the project is assumed to be the same rate.

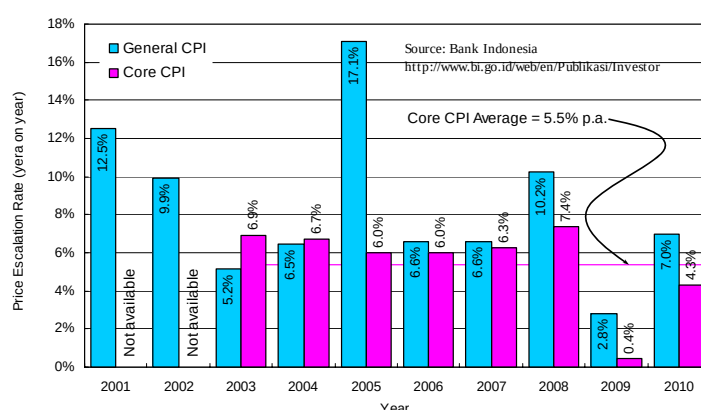
Table 14.3.1 Price Index of OECD Member Country Average

Year	Index	Yearly Escalation
2005	100.00	1.019
2006	101.92	1.019
2007	104.04	1.021
2008	106.31	1.022
2009	108.15	1.017
2010	109.54	1.013

Source: OECD Statistics

(<http://stats.oecd.org/Index.aspx>) for years 1996 to 2010. Study Team's assumption for 2011.

The core price index is also focused on the local cost portion. According to the Bank of Indonesia, the latest value is 5.5% p.a. as of end 2010, which is slightly less than the country's target, 6.0% p.a. Because the financial analysis is made in terms of US Dollars, one should incorporate the currency exchange effect into the price escalation rate for the local currency portion. As the recent 10 year trend of the exchange rate shows 0.5% appreciation of Indonesian Rupiah, the financial analysis decides the price escalation rate to be 5.0% p.a. for the local currency portion.



Source: Bank of Indonesia <http://www.bi.go.id/web/en/Publikasi/Investor+Relation+Unit/>

Figure 14.3.1 Price Escalation Rates of Indonesia

(1) Price Escalation for CAPEX

Because the foreign and local currency cost ratio is estimated to be 48:52 for the construction, its price escalation rate becomes 3.22% p.a. ($= 1.3\% \times 0.48 + 5.0\% \times 0.52$), taking a weighted average of the two currencies.

(2) Price Escalation for OPEX

Because daily operating cost is expected to be incurred mostly in the local currency, the price escalation rate for OPEX is assumed to be 5.0% p.a. that corresponds to the local currency escalation.

(3) Price Escalation for Non-civil Works

Because the foreign and local currency cost ratio is estimated to be 78:22 for the non-civil works,

its price escalation rate becomes 2.11% p.a. ($= 1.3\% \times 0.78 + 5.0\% \times 0.22$), taking a weighted average of the two currencies.

14.3.2.4 Discount Rate

10% p.a. of a discount rate is assumed in this financial evaluation.

14.3.2.5 Depreciation and Amortization

It is assumed that all of the hardware (tangible assets) is depreciated and counted as the accounting expenses. The applied method is the straight line. In the last year of the financial evaluation, the residual values are taken into account.

14.3.2.6 Taxes

The following tax conditions are assumed for the project implementation and operation. No tax holidays are assumed.

- VAT will be fully paid by the project owner, PLN.
- 25% of profit tax to the project owner for the operation years is applied.

Note that the water charges levied by the regional government is separately counted in the variable operating cost, and therefore it is not treated as tax.

14.3.2.7 Hurdle Rate of Return

The hurdle rate, which is the minimum desired FIRR of a project, is assumed to be the Weighted Average Cost of Capital (WACC) of the project-operating entity. WACC reflects the overall costs of combined debt and equity capital used to finance business operations, adjusted for tax savings due to interest payments. Assuming that PLN is the project-operating entity of the project in question, WACC was computed to be 2.0%, as detailed in Table 14.3.2.

Table 14.3.2 Computation of Weighted Average Cost of Capital

Items	MDB ⁰⁾	PLN	Total
a. Financing Weight	75.00%	25.00%	100.00%
b. Nominal cost of funds	3.40% ¹⁾	12.55% ²⁾	
c. Tax rate	25.00%	25.00%	
d. Tax-adjusted nominal cost	2.55%	9.41%	
e. Inflation Rate	1.30%	5.00%	
f. Real Cost	1.23%	4.20%	
g. Weighted component of WACC	0.93%	1.05%	1.98%

⁰⁾ Multilateral Development Banks, such as ADB and WBG

¹⁾ 5-year swap rate as of March 2009 = 2.7% plus ADB loan spread = 0.2% plus onlending premium = 0.5%

²⁾ PLN XI Bonds Series B Year 2010 with terms of 10 years, interest rate of 12.55% p.a.

$$d = b \times (1 - c) \quad f = (1 + d) / (1 + e) - 1$$

Source: Study Team

14.3.3 FINANCIAL COST

14.3.3.1 Capital Expenditure

As discussed earlier in Table 14.2.3, the financial capital expenditure (CAPEX) is estimated to be US\$209 million, excluding costs required for the feasibility study. The financial CAPEX is assumed to be disbursed during seven years of leading time with the yearly disbursement ratios; 0%, 0%, 1.0%, 8.5%, 26.5%, 42.7%, and 21.4%. The breakdowns are given in Table 14.3.3.

Table 14.3.3 Financial CAPEX

(a) CAPEX Breakdown Excluding Financing Charges					US\$M			
Cost Items		FC	LC	Total				
Civil Works		20.52	77.46	97.98				
Generating Equipment		44.45	9.88	54.33				
Mechanical Works & Transmission		8.85	5.01	13.85				
Others		2.76	10.14	12.90				
Price Escalation before COD		5.22	25.17	30.39				
Total		81.80	127.65	209.45				
(b) Expected Disbursement								US\$M
Year	2011	2012	2013	2014	2015	2016	2017	Total
FC	0.00	0.00	0.26	4.22	11.35	36.19	29.77	81.80
LC	0.00	0.00	1.76	13.50	44.07	53.19	15.13	127.65
Total	0.00	0.00	2.02	17.72	55.43	89.38	44.90	209.45
Percentage	0.0%	0.0%	1.0%	8.5%	26.5%	42.7%	21.4%	100.0%
FC = foreign currency, LC = local currency								
Source: Study Team								

14.3.3.2 Operating Expenditure

Despite different values, the financial operating expenditure (OPEX) can be estimated in a same manner as done in the economic analysis. There are three kinds of the financial OPEX; i) fixed operating cost, which will be incurred no matter how much electricity is generated, ii) variable operating cost, which will be burdened proportionally to electricity generated, and iii) major maintenance cost, which will cost periodically for replacing or overhauling aged machines.

- Fixed operating cost US\$1.1 mill. p.a., which is 0.6% to the construction cost
- Variable operating cost US\$0.3 mill. p.a., which is of Rp. 5.0/kWh for water charge and Rp. 1.5/kWh for lubricants
- Major maintenance cost US\$3.5 mill. p.a., which is equal to the annualized value of the generating equipment, mechanical works and transmission line cost, US\$71.1 mill. with 2.11% p.a. of price escalation

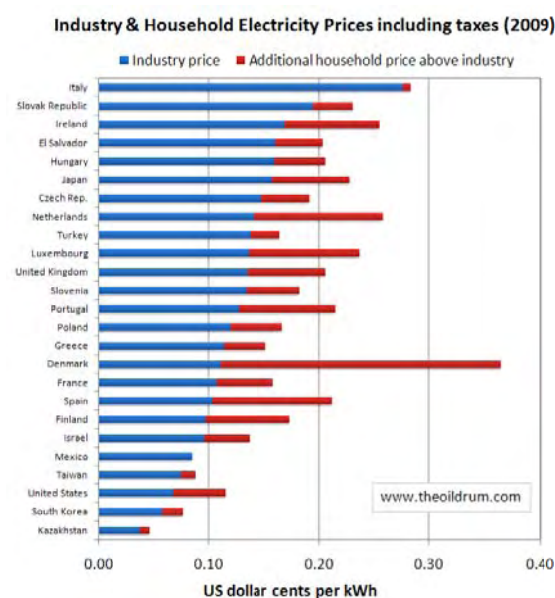
The yearly operating cost is calculated to be around US\$4.9 million at the 2011 price level.

14.3.4 FINANCIAL BENEFIT

14.3.4.1 Electricity Tariff

Decision of the electricity tariff is of paramount importance. Because the present electricity charges of PLN include the government subsidy effects, its simple adoption may mislead us into underestimating a project.

The financial analysis has chosen the latest average generation cost of PLN as the appropriate electricity tariff (a shadow tariff). It is estimated to be US¢9.945/kWh, which is of the total cost incurred for electricity generation by PLN plus the total government subsidy divided by the total electricity sold by PLN. The data used for this computation is tabulated in Table 14.3.4. This value is evaluated slightly greater than the present middle voltage generation cost by PLN for the Java-Bali System, and much less than the present high voltage generation cost by PLN for the North Sumatra System, as compared in Table 14.3.5. Further, it is within the modest and appropriate tariff range among major countries, as compared in Figure 14.3.2. The financial analysis decides that the electricity tariff of the questioned hydropower project is US¢9.945/kWh as of 2011.



Source: Oil Drum

Figure 14.3.2 Electricity Prices in Major Countries

Table 14.3.4 Electricity Sales and Subsidy

Year	Electricity Sales		Subsidy		Sum	Electricity (GWh)	Tariff P	Tariff S
	Rp T	US\$M	Rp T	US\$M	US\$M		US¢/kWh	US¢/kWh
2002	39,018	4,335	4,739	527	4,862	108,360	4.001	4.487
2003	49,810	5,534	4,097	455	5,990	113,020	4.897	5.300
2004	58,232	6,470	3,470	386	6,856	120,244	5.381	5.702
2005	63,246	7,027	12,511	1,390	8,417	127,370	5.517	6.609
2006	70,735	7,859	32,909	3,657	11,516	133,108	5.905	8.652
2007	76,286	8,476	36,605	4,067	12,543	142,441	5.951	8.806
2008	84,250	9,361	78,577	8,731	18,092	149,437	6.264	12.107
2009	90,172	10,019	53,720	5,969	15,988	156,797	6.390	10.197
2010*	N/A	N/A	55,100	6,122	N/A	194,459	7.479	10.627
2011*	N/A	N/A	41,000	4,556	N/A	201,977	7.689	9.945

Electricity = Electricity sold by PLN

Tariff P = average electricity charge without subsidy

Tariff S = electricity charge with subsidy

* Estimations for "Electricity Sold" and "Tariff P" based on the past trends in 2005 to 2009.

Rp.9,000/US\$ is used for Rupiah to US\$ conversion.

Source: Study Team based on PLN Statistics 2009 and MOF data

Table 14.3.5 Electricity Generation Cost by PLN Rp./kWh

Areas	High Voltage	Middle Voltage	Low Voltage
1. North Sumatra	1,891	1,984 to 2,158	2,308 to 2,603
2. South Sumatra	565	667 to 1,164	860 to 1,433
3. Bangka Briton	-	2,476	2,919
4. West Kalimantan	2,315	2,546	3,145
5. Central and South Kalimantan	1,148	1,611	1,998
6. East Kalimantan	1,732	1,965	2,260
7. North Sulawesi	974	1,676	2,063
8. South Sulawesi	1,103	1,249	1,505
9. Maluku	-	2,320	2,919
10. Irian Jaya	-	2,526	3,192
11. NTB	-	2,289	2,743
12. NTT	-	2,433	3,072
13. Java-Bali	783	849 to 859	1,005 to 1,030

Source: Circular No.269-12/26/600.3/2008, Directorate General of Electricity Utilization, MEMR

The electricity tariff should be escalated, so that the project-operating entity can make proper profit from it and can fulfill his financial obligations. In this financial analysis, the minimal tariff escalation is assumed. That is, the extent of escalation yielded from the OPEX increase due to inflation.

The tariff escalation was then computed to be 0.686% p.a. (yearly OPEX divided by electricity sales multiplied by price escalation for OPEX = $4.9 \text{ US\$M} \div 36.0 \text{ US\$M} \times 5.0\%$ for 2011). The tariff US\$9.945/kWh as of 2011 will be then increased to US\$10.432/kWh as of 2018, the first operating year.

14.3.4.2 Project Revenue

The project revenue is straightforward. It is of the electricity tariff multiplied by the expected electricity sold. The first operating year revenue as of 2018 is;

$$\text{US\$37.8 mill./year} = \text{Rp. } 0.10432/\text{kWh} \times 362 \text{ GWh/year}$$

Where 362 GWh/year is the net annual energy that is equal to 416 GWh of the gross energy subtracted by 12.93% of loss, being composed of 3.00% of the station use and 9.93% of the transmission/distribution loss.

Benefit from Certified Emission Reduction (CER) was considered in the sensitivity analysis. The CER benefit discussed in the economic analysis is, however, the maximum yield of the CER benefit. Practically, the CER benefit is shared by stakeholders, namely, a project host, CDM investor(s), and the government concerned. In this financial analysis, 50% of the CER benefit computed in the economic analysis is counted as the financial CER benefit in order not to overestimate the profit from it. Thus, the financial CER benefit is assumed to be:

$$\text{CO}_2 \text{ emission factor} = 0.743 \text{ tCO}_2/\text{MWh}$$

$$\text{Expected CER price} = 12.5 \text{ US\$}/\text{tCO}_2$$

$$\begin{aligned}\text{Financial CER Benefit} &= 0.5 \times \text{Effective Electricity Generated} \times \text{CO}_2 \text{ emission factor} \times \text{CER} \\ &\quad \text{price} \\ &= 0.5 \times 362 \text{ GWh/year} \times 0.743 \text{ tCO}_2/\text{MWh} \times 12.5 \text{ US\$/tCO}_2 \\ &= 1.68 \text{ US\$M/year}\end{aligned}$$

14.3.5 FINANCIAL ANALYSIS

14.3.5.1 Interest Free Cash Flow

An interest free cash flow here evaluates the project's profitability without financing charges but with income tax. The financial stream is tabulated in Table 14.3.6. The key indicators in present worth are:

$$\begin{aligned}\text{NPV}_p &= \text{US\$10.6 million} & \text{FIRR} &= 10.7\% \\ \text{B/C} &= 1.05\end{aligned}$$

The FIRR computed is much greater than 2.0% of the hurdle rate, and therefore PLN as the project-operating entity will be able to make profit from the project with high probability. However, this FIRR does not reach a magnificent level, say 13%, which may make foreign investors keen for investment in the country.

Table 14.3.6 Interest Free Financial Stream

Year	Cost				US\$ million			GWh	
	CAPEX	O&M	Tax	Sub-total	Benefit			Net Benefit	Energy Supply
					Sales	CER	Sub-total		
2011 -6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
2012 -5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
2013 -4	2.02	0.00	0.00	2.02	0.00	0.00	0.00	-2.02	0
2014 -3	17.72	0.00	0.00	17.72	0.00	0.00	0.00	-17.72	0
2015 -2	55.43	0.00	0.00	55.43	0.00	0.00	0.00	-55.43	0
2016 -1	89.38	0.00	0.00	89.38	0.00	0.00	0.00	-89.38	0
2017 0	44.90	0.00	0.00	44.90	0.00	0.00	0.00	-44.90	0
2018 1	0.00	5.61	6.13	11.74	37.79	0.00	37.79	26.04	362
2019 2	0.00	5.79	6.15	11.94	38.05	0.00	38.05	26.10	362
2020 3	0.00	5.98	6.17	12.15	38.31	0.00	38.31	26.16	362
2021 4	0.00	6.17	6.19	12.36	38.57	0.00	38.57	26.21	362
2022 5	0.00	6.37	6.20	12.58	38.83	0.00	38.83	26.26	362
2023 6	0.00	6.58	6.22	12.80	39.10	0.00	39.10	26.30	362
2024 7	0.00	6.80	6.23	13.03	39.37	0.00	39.37	26.34	362
2025 8	0.00	7.03	6.27	13.30	39.64	0.00	39.64	26.34	362
2026 9	0.00	7.26	6.31	13.57	39.91	0.00	39.91	26.34	362
2027 10	0.00	7.51	6.35	13.86	40.18	0.00	40.18	26.33	362
2028 11	0.00	7.76	6.39	14.15	40.46	0.00	40.46	26.31	362
2029 12	0.00	8.03	6.42	14.45	40.74	0.00	40.74	26.29	362
2030 13	0.00	8.30	6.45	14.75	41.02	0.00	41.02	26.26	362
2031 14	0.00	8.59	6.48	15.07	41.30	0.00	41.30	26.23	362
2032 15	0.00	8.88	6.51	15.39	41.58	0.00	41.58	26.19	362
2033 16	0.00	9.19	6.53	15.73	41.87	0.00	41.87	26.14	362
2034 17	0.00	9.52	6.56	16.07	42.15	0.00	42.15	26.08	362
2035 18	0.00	9.85	6.58	16.43	42.44	0.00	42.44	26.01	362
2036 19	0.00	10.20	6.59	16.79	42.73	0.00	42.73	25.94	362
2037 20	0.00	10.56	6.61	17.17	43.03	0.00	43.03	25.86	362
2038 21	0.00	10.94	6.62	17.56	43.32	0.00	43.32	25.76	362
2039 22	0.00	11.34	6.62	17.96	43.62	0.00	43.62	25.66	362
2040 23	0.00	11.75	6.62	18.37	43.92	0.00	43.92	25.54	362
2041 24	0.00	12.18	6.62	18.80	44.22	0.00	44.22	25.42	362
2042 25	0.00	12.62	6.62	19.24	44.52	0.00	44.52	25.28	362
2043 26	0.00	13.09	6.61	19.70	44.83	0.00	44.83	25.13	362
2044 27	0.00	13.57	6.60	20.17	45.13	0.00	45.13	24.96	362
2045 28	0.00	14.08	6.58	20.66	45.44	0.00	45.44	24.78	362
2046 29	0.00	14.61	6.56	21.16	45.75	0.00	45.75	24.59	362
2047 30	0.00	15.16	6.53	21.68	46.07	0.00	46.07	24.38	362
2048 31	0.00	14.14	0.00	14.14	0.00	0.00	0.00	-14.14	0
2049 32	0.00	16.33	6.04	22.37	46.70	0.00	46.70	24.33	362
2050 33	0.00	16.95	5.97	22.92	47.02	0.00	47.02	24.10	362
2051 34	0.00	17.61	5.89	23.49	47.35	0.00	47.35	23.85	362
2052 35	0.00	18.29	5.80	24.08	47.67	0.00	47.67	23.59	362
2053 36	0.00	19.00	5.70	24.70	48.00	0.00	48.00	23.30	362
2054 37	0.00	19.74	5.60	25.34	48.33	0.00	48.33	22.99	362
2055 38	0.00	20.51	5.49	26.00	48.66	0.00	48.66	22.66	362
2056 39	0.00	21.32	5.37	26.69	48.99	0.00	48.99	22.30	362
2057 40	0.00	22.16	5.24	27.41	49.33	0.00	49.33	21.92	362
2058 41	0.00	23.05	5.11	28.15	49.66	0.00	49.66	21.51	362
2059 42	0.00	23.97	4.96	28.93	50.01	0.00	50.01	21.08	362
2060 43	0.00	24.93	4.81	29.73	50.35	0.00	50.35	20.61	362
2061 44	0.00	25.93	4.64	30.57	50.69	0.00	50.69	20.12	362
2062 45	0.00	26.98	4.47	31.45	51.04	0.00	51.04	19.59	362
2063 46	0.00	28.08	4.28	32.36	51.39	0.00	51.39	19.03	362
2064 47	0.00	29.23	4.08	33.31	51.74	0.00	51.74	18.44	362
2065 48	0.00	30.43	3.87	34.30	52.10	0.00	52.10	17.80	362
2066 49	0.00	31.68	3.64	35.32	52.46	0.00	52.46	17.13	362
2067 50	-56.16	32.99	3.41	-19.76	52.82	0.00	52.82	72.58	362
Total	153.29	748.64	287.65	1189.58	2198.16	0.00	2198.16	1008.58	17,748
PV	133.42	45.97	34.92	214.31	224.89	0.00	224.89	10.58	–
Annu	13.40	4.62	3.51	21.52	22.59	0.00	22.59	1.06	–

NPV_r = 10.58 FIRR = 10.74%
 PV stands for a present value discounted by 10% p.a.

Annu stands for an annualized value of respective present value.

B/C = 1.05 Cost = US\$5.9/kWh

Source: Study Team

The total unit generation cost is US\$5.9/kWh (annualized total cost divided by annual energy supplied). The breakdown follows:

Table 14.3.7 Generation Cost Breakdown

	CAPEX	O&M	Tax	Total	Energy (GWh)
Annualized Value (US\$ mill.)	13.40	4.62	3.51	21.52	362.21
Generation Cost (US ¢ /kWh)	3.70	1.27	0.97	5.94	–

Source: Study Team

14.3.5.2 Return on Investment

The interest free cash flow discussed in the previous subsection corresponds to the entire return in case when no loan is arranged. Reality often demands some loan to complete a project and another set of the cash flow analysis is needed. It is the cash flow in consideration of the financing charges and reflects the investor's return. It is often called "Return on Investment" or ROI. For ROI evaluation, DSCR (debt service coverage ratio) and LLCR (loan life coverage ratio) are introduced to measure a project's ability to generate enough revenue to cover the cost of its mortgage payments. DSCR is calculated by dividing the net operating income by the total debt service. LLCR is a measure of the long term cash flow over the scheduled life of the debt in view of how a project can repay the outstanding debt balance.

Assuming the loan conditions in Table 14.3.8, the return on investment was computed as given in Table 14.3.9 by using a DCF model. The net present value and rate of return are:

$$NPV_I = \text{US\$75.3 million} \quad \text{ROI} = 24.5\%$$

Table 14.3.8 Loan Conditions Assumed for Financial Cash Flow

Lender	Interest Rate (p.a)	Front-end fee	Commitment fee (p.a)	Grace period	Repay period	Loan share
Bilateral Institution	1.90%	0.00%	0.75%	7 years	25 years	75%

- Notes
1. The front-end fee will be charged only at the time of loan agreement. The commitment fee is charged against unused loan amount and will decrease gradually and end at null when the loan amount is fully disbursed.
 2. Interest rate is assumed constant and being composed of 1.4% p.a. of JICA's standard rate for medium income countries plus 0.5% p.a. of onlending spread by MOF.
 3. Grace period includes 4 years of construction.
 4. No insurance is counted.

Source: Study Team

The project can be evaluated financially feasible from a long term view. The breakeven is 3 years after commissioning. Because no revenue is expected in the replacement year scheduled 30 years after commissioning, however, the project will not be able to fulfill the debt service obligation in the same year. As an enough return is expected, the project can easily overcome the debt service issue. For example, if 4% of the annual net profit is deposited every year into a saving account, the project will easily be able to have enough cash when no revenue is expected due to machine replacement.

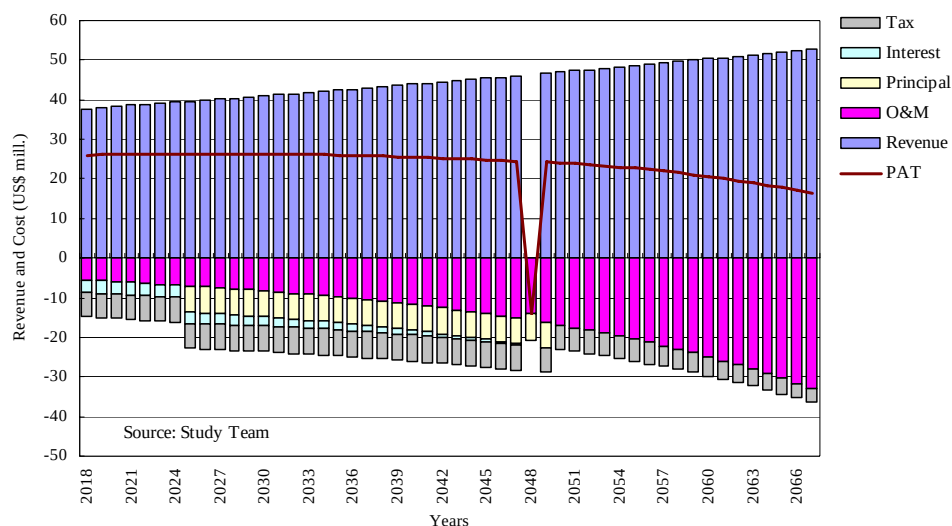


Figure 14.3.3 Cash Inflow and Outflow

Assuming the aforementioned explicit savings for the replacement cost, DSCR and LLCR can be raised as:

$$\text{Minimum DSCR} = 1.7 > 1.0 \quad \text{Minimum LLCR} = 2.5 > 1.0$$

Now, all of the indicators show enough numbers and therefore one can evaluate the hydropower project in question is financially viable. The debt balance is illustrated in Figure 14.3.4. The profit and loss calculations are given in Table 14.3.10.

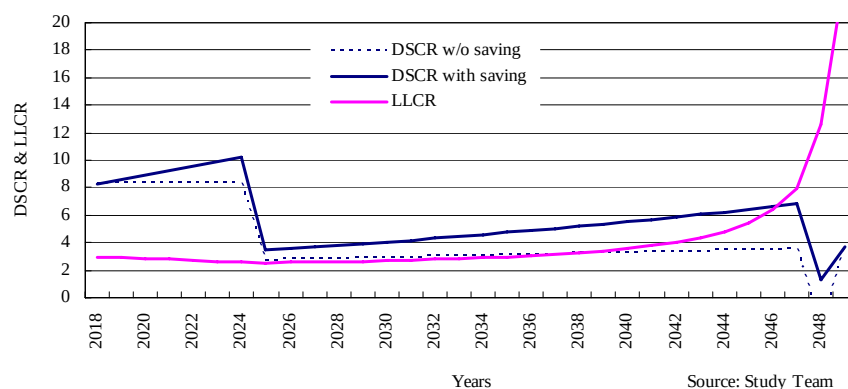


Figure 14.3.4 Debt Balance

Table 14.3.9 Financial Cash Flow for ROI

Year	Invest	Cash Generation						US\$ million	
								Benefit	
		Sales	Residual	O&M	Interest	Repay	Tax	Net	Sum
2011 -6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2012 -5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2013 -4	1.83	0.00	0.00	0.00	0.01	0.00	0.00	-1.83	-1.83
2014 -3	15.98	0.00	0.00	0.00	0.05	0.00	0.00	-16.03	-17.86
2015 -2	29.42	0.00	0.00	0.00	0.73	0.00	0.00	-30.15	-48.00
2016 -1	0.00	0.00	0.00	0.00	2.90	0.00	0.00	-2.90	-50.90
2017 0	0.00	0.00	0.00	0.00	3.44	0.00	0.00	-3.44	-54.34
2018 1	0.00	37.79	0.00	5.61	3.10	0.00	6.13	22.95	-31.40
2019 2	0.00	38.05	0.00	5.79	3.10	0.00	6.15	23.01	-8.39
2020 3	0.00	38.31	0.00	5.98	3.10	0.00	6.17	23.06	14.67
2021 4	0.00	38.57	0.00	6.17	3.10	0.00	6.19	23.11	37.78
2022 5	0.00	38.83	0.00	6.37	3.10	0.00	6.20	23.16	60.94
2023 6	0.00	39.10	0.00	6.58	3.10	0.00	6.22	23.20	84.14
2024 7	0.00	39.37	0.00	6.80	3.10	0.00	6.23	23.24	107.38
2025 8	0.00	39.64	0.00	7.03	2.97	6.52	6.27	16.84	124.23
2026 9	0.00	39.91	0.00	7.26	2.85	6.52	6.31	16.96	141.19
2027 10	0.00	40.18	0.00	7.51	2.73	6.52	6.35	17.08	158.27
2028 11	0.00	40.46	0.00	7.76	2.60	6.52	6.39	17.19	175.46
2029 12	0.00	40.74	0.00	8.03	2.48	6.52	6.42	17.29	192.75
2030 13	0.00	41.02	0.00	8.30	2.35	6.52	6.45	17.39	210.14
2031 14	0.00	41.30	0.00	8.59	2.23	6.52	6.48	17.48	227.62
2032 15	0.00	41.58	0.00	8.88	2.11	6.52	6.51	17.56	245.18
2033 16	0.00	41.87	0.00	9.19	1.98	6.52	6.53	17.63	262.81
2034 17	0.00	42.15	0.00	9.52	1.86	6.52	6.56	17.70	280.51
2035 18	0.00	42.44	0.00	9.85	1.73	6.52	6.58	17.76	298.27
2036 19	0.00	42.73	0.00	10.20	1.61	6.52	6.59	17.81	316.08
2037 20	0.00	43.03	0.00	10.56	1.49	6.52	6.61	17.85	333.93
2038 21	0.00	43.32	0.00	10.94	1.36	6.52	6.62	17.88	351.81
2039 22	0.00	43.62	0.00	11.34	1.24	6.52	6.62	17.90	369.70
2040 23	0.00	43.92	0.00	11.75	1.12	6.52	6.62	17.91	387.61
2041 24	0.00	44.22	0.00	12.18	0.99	6.52	6.62	17.90	405.51
2042 25	0.00	44.52	0.00	12.62	0.87	6.52	6.62	17.89	423.40
2043 26	0.00	44.83	0.00	13.09	0.74	6.52	6.61	17.86	441.27
2044 27	0.00	45.13	0.00	13.57	0.62	6.52	6.60	17.82	459.09
2045 28	0.00	45.44	0.00	14.08	0.50	6.52	6.58	17.77	476.86
2046 29	0.00	45.75	0.00	14.61	0.37	6.52	6.56	17.70	494.56
2047 30	0.00	46.07	0.00	15.16	0.25	6.52	6.53	17.61	512.17
2048 31	0.00	0.00	0.00	14.14	0.12	6.52	0.00	-20.79	491.38
2049 32	0.00	46.70	0.00	16.33	0.00	6.52	6.04	17.81	509.19
2050 33	0.00	47.02	0.00	16.95	0.00	0.00	5.97	24.10	533.29
2051 34	0.00	47.35	0.00	17.61	0.00	0.00	5.89	23.85	557.14
2052 35	0.00	47.67	0.00	18.29	0.00	0.00	5.80	23.59	580.73
2053 36	0.00	48.00	0.00	19.00	0.00	0.00	5.70	23.30	604.03
2054 37	0.00	48.33	0.00	19.74	0.00	0.00	5.60	22.99	627.02
2055 38	0.00	48.66	0.00	20.51	0.00	0.00	5.49	22.66	649.68
2056 39	0.00	48.99	0.00	21.32	0.00	0.00	5.37	22.30	671.98
2057 40	0.00	49.33	0.00	22.16	0.00	0.00	5.24	21.92	693.90
2058 41	0.00	49.66	0.00	23.05	0.00	0.00	5.11	21.51	715.42
2059 42	0.00	50.01	0.00	23.97	0.00	0.00	4.96	21.08	736.49
2060 43	0.00	50.35	0.00	24.93	0.00	0.00	4.81	20.61	757.11
2061 44	0.00	50.69	0.00	25.93	0.00	0.00	4.64	20.12	777.23
2062 45	0.00	51.04	0.00	26.98	0.00	0.00	4.47	19.59	796.82
2063 46	0.00	51.39	0.00	28.08	0.00	0.00	4.28	19.03	815.85
2064 47	0.00	51.74	0.00	29.23	0.00	0.00	4.08	18.44	834.29
2065 48	0.00	52.10	0.00	30.43	0.00	0.00	3.87	17.80	852.09
2066 49	0.00	52.46	0.00	31.68	0.00	0.00	3.64	17.13	869.22
2067 50	0.00	52.82	56.16	32.99	0.00	0.00	3.41	72.58	941.80
Total	47.22	2,198.16	56.16	748.64	65.97	163.03	287.65	941.80	–
PV	33.61	224.89	0.27	45.97	18.18	17.15	34.92	75.33	–
Annu	3.38	22.59	0.03	4.62	1.83	1.72	3.51	7.57	–

NPV_i = 75.33 ROI = 24.47%

Source: Study Team

PV stands for a present value discounted by 10% p.a.

Annu stands for an annualized value of respective present value.

Table 14.3.10 Profit and Loss

Year	Revenue	Interest	O&M Cost	Depreciation	US\$ million			DSCR	LLCR
					PBT	Tax	PAT		
2011 -6	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
2012 -5	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
2013 -4	0.00	0.01	0.00	0.00	-2.03	0.00	-2.03		
2014 -3	0.00	0.05	0.00	0.00	-17.77	0.00	-17.77		
2015 -2	0.00	0.73	0.00	0.00	-56.15	0.00	-56.15		
2016 -1	0.00	2.90	0.00	0.00	-92.28	0.00	-92.28		
2017 0	0.00	3.44	0.00	0.00	-48.34	0.00	-48.34		
2018 1	37.79	3.10	5.61	4.55	24.52	6.13	18.39	8.30	2.96
2019 2	38.05	3.10	5.79	4.55	24.60	6.15	18.45	8.61	2.90
2020 3	38.31	3.10	5.98	4.55	24.68	6.17	18.51	8.93	2.84
2021 4	38.57	3.10	6.17	4.55	24.75	6.19	18.56	9.24	2.78
2022 5	38.83	3.10	6.37	4.55	24.81	6.20	18.61	9.55	2.72
2023 6	39.10	3.10	6.58	4.55	24.86	6.22	18.65	9.87	2.66
2024 7	39.37	3.10	6.80	4.55	24.92	6.23	18.69	10.18	2.60
2025 8	39.64	2.97	7.03	4.55	25.08	6.27	18.81	3.43	2.54
2026 9	39.91	2.85	7.26	4.55	25.24	6.31	18.93	3.55	2.56
2027 10	40.18	2.73	7.51	4.55	25.40	6.35	19.05	3.67	2.59
2028 11	40.46	2.60	7.76	4.55	25.54	6.39	19.16	3.79	2.62
2029 12	40.74	2.48	8.03	4.55	25.68	6.42	19.26	3.91	2.65
2030 13	41.02	2.35	8.30	4.55	25.81	6.45	19.36	4.04	2.69
2031 14	41.30	2.23	8.59	4.55	25.93	6.48	19.45	4.18	2.73
2032 15	41.58	2.11	8.88	4.55	26.04	6.51	19.53	4.31	2.77
2033 16	41.87	1.98	9.19	4.55	26.14	6.53	19.60	4.45	2.83
2034 17	42.15	1.86	9.52	4.55	26.22	6.56	19.67	4.59	2.89
2035 18	42.44	1.73	9.85	4.55	26.30	6.58	19.73	4.74	2.96
2036 19	42.73	1.61	10.20	4.55	26.37	6.59	19.78	4.89	3.04
2037 20	43.03	1.49	10.56	4.55	26.42	6.61	19.82	5.05	3.14
2038 21	43.32	1.36	10.94	4.55	26.46	6.62	19.85	5.20	3.25
2039 22	43.62	1.24	11.34	4.55	26.49	6.62	19.87	5.37	3.39
2040 23	43.92	1.12	11.75	4.55	26.50	6.62	19.87	5.53	3.55
2041 24	44.22	0.99	12.18	4.55	26.50	6.62	19.87	5.70	3.75
2042 25	44.52	0.87	12.62	4.55	26.48	6.62	19.86	5.87	4.01
2043 26	44.83	0.74	13.09	4.55	26.44	6.61	19.83	6.05	4.34
2044 27	45.13	0.62	13.57	4.55	26.39	6.60	19.79	6.23	4.79
2045 28	45.44	0.50	14.08	4.55	26.31	6.58	19.74	6.42	5.42
2046 29	45.75	0.37	14.61	4.55	26.22	6.56	19.67	6.61	6.36
2047 30	46.07	0.25	15.16	4.55	26.11	6.53	19.58	6.81	7.95
2048 31	0.00	0.12	14.14	2.18	-16.45	0.00	-16.45	1.28	12.57
2049 32	46.70	0.00	16.33	6.20	24.18	6.04	18.13	3.69	23.57
2050 33	47.02	0.00	16.95	6.20	23.87	5.97	17.90	n.a.	n.a.
2051 34	47.35	0.00	17.61	6.20	23.54	5.89	17.66	n.a.	n.a.
2052 35	47.67	0.00	18.29	6.20	23.19	5.80	17.39	n.a.	n.a.
2053 36	48.00	0.00	19.00	6.20	22.80	5.70	17.10	n.a.	n.a.
2054 37	48.33	0.00	19.74	6.20	22.39	5.60	16.79	n.a.	n.a.
2055 38	48.66	0.00	20.51	6.20	21.95	5.49	16.46	n.a.	n.a.
2056 39	48.99	0.00	21.32	6.20	21.47	5.37	16.11	n.a.	n.a.
2057 40	49.33	0.00	22.16	6.20	20.97	5.24	15.72	n.a.	n.a.
2058 41	49.66	0.00	23.05	6.20	20.42	5.11	15.32	n.a.	n.a.
2059 42	50.01	0.00	23.97	6.20	19.84	4.96	14.88	n.a.	n.a.
2060 43	50.35	0.00	24.93	6.20	19.22	4.81	14.42	n.a.	n.a.
2061 44	50.69	0.00	25.93	6.20	18.56	4.64	13.92	n.a.	n.a.
2062 45	51.04	0.00	26.98	6.20	17.86	4.47	13.40	n.a.	n.a.
2063 46	51.39	0.00	28.08	6.20	17.11	4.28	12.84	n.a.	n.a.
2064 47	51.74	0.00	29.23	6.20	16.32	4.08	12.24	n.a.	n.a.
2065 48	52.10	0.00	30.43	6.20	15.48	3.87	11.61	n.a.	n.a.
2066 49	52.46	0.00	31.68	6.20	14.58	3.64	10.93	n.a.	n.a.
2067 50	52.82	0.00	32.99	6.20	13.63	3.41	10.22	n.a.	n.a.
Total	2,198.16	65.97	748.64	256.52	917.57	287.65	629.92	–	–
PV	224.89	18.18	45.97	25.82	1.23	34.92	-33.69	–	–
Annu	22.59	1.83	4.62	2.59	0.12	3.51	-3.38	–	–

PV stands for a present value discounted by 10% p.a.

Source: Study Team

Annu stands for an annualized value of respective present value.

14.3.6 FINANCIAL SENSITIVITY

A sensitivity analysis was conducted to examine the extent to which the financial indicators change for different values of the major variables. In this financial analysis, 5 cases are tested, namely, + CDM, – 10% Tariff, – 10% Annual Energy, + 10% CAPEX & OPEX, and + 1 year delay of commissioning.

The sensitivity analysis has confirmed that changes of the financial indicators still remain in a viable range, as compared in Table 14.3.11.

Table 14.3.11 Financial Indicators

Sensitivity Analysis	FIRR	US\$M	ROI	US\$M	
0. Base Case	10.7%	10.6	24.5%	75.3	the base case
1. +CDM	11.2%	17.6	25.5%	82.4	CDM benefit added to the base case
2. -10% Tariff	9.5%	-6.3	22.0%	58.5	electricity tariff 10% less
3. -10% Energy	9.5%	-6.3	22.0%	58.5	less annual energy by 10%
4. +10% CAPEX	9.7%	-5.0	22.5%	66.5	greater cost by 10%
5. COD Delayed by 1 yr	9.9%	-1.0	21.4%	65.1	commissioning delayed by 1 year

Columns with US\$M correspond to respective net present values

Source: Study Team

14.4 BUSINESS SCHEME AND FINANCING PLAN

14.4.1 INTRODUCTION TO BUSINESS SCHEME AND FINANCING PLAN

Hydropower development requires large initial investment. Because the public sector budgets are limited, private investments are desired. However, there are many stagnated hydropower projects due to the higher natural condition risks and greater investment costs than typical thermal plants. Particularly in IPPs, these high risk and high cost issues discourage private investors and make the financing more difficult. Today, hydropower development looks possible only when the public sector implements it, with a very few exceptions.

Therefore, a Public-Private Partnership (PPP) should be sought. A PPP potentially can reduce the public sector's liability and can accelerate private investments in the country as well. Among several PPP scheme candidates as compared in the following table, so-called the Hybrid or "the vertical separation" mechanism has been chosen as the best-fitting PPP business scheme in this financial analysis.

Table 14.4.1 Evaluation of Possible PPP Schemes

Effect	Hybrid	OBA	BTO for Value	Joint Venture
i) Reduction of Implementation Cost	A certain amount of the cost reduction can be expected from the financing charges and insurance cost.			Depends on depth of public sector's involvement
ii) Relief of Private Sector's Risks	The hydro specific natural condition risk could be unbundled.	The hydro specific natural condition risk remains, because the completion risk needs to be borne 100% by the private sector.		Not sufficient for the private sector.
iii) Optimal Input of Public Money	Because of remarkable private investment, all of 4 schemes must be effective for reducing the public money input, once a project is realized. It is quite possible to optimize the public money input to the hydropower projects.			

Hybrid (a vertical separation): Design and construction role is shared by 2 sectors.

OBA (Output-Based Aid): Public sector subsidizes project outputs achieved by private sector.

BTO for Value: Public sector buys out a ready-to-use project developed by private sector.

Joint Venture: 2 sectors form a joint venture entity for a project.

Source: The Study on Optimal Electric Power Development in Sulawesi, JICA, 2008

14.4.2 DESIGN OF POSSIBLE PPP BUSINESS SCHEME

Only a proper risk allocation can bring about the feasible and sustainable business scheme, which is a basis of the financing plan of a project. In the private investment in hydropower development, four major risks are focused. They are, i) financing risk, ii) political risk, iii) hydrological risk, and iv) design and construction risk. Here, the hydrological risk raises the commercial risk, because unexpected river runoff is directly linked to the electricity generation and revenues of the project. It is of paramount importance for a PPP business scheme to reduce these risks to a level that a private investor can accept. The following table examines the power station and non-power station components to what extent each risk can be reduced from the private investor's point of view. Where, the power station component is literally the power station including the generating equipment, related mechanical works, and necessary civil works housing thereof. The non-power station components are all civil works upstream of the power station, substantially the headworks and tunnel waterway.

Table 14.4.2 Effects of Risk Mitigation for Private Sector

	Power Station Component	Non-Power Station Components
Financing Risk	The risk can be minimized, if the following 3 risks are nicely mitigated, and if the currency exchange risk can be taken away by the business contract.	
Political Risk	The risk can be eased, if a proper business contract is exercised. Government guarantees against currency inconvertibility, expropriation, etc. can greatly encourage a private investor.	
Hydrological Risk	Substantially, the commercial risk. The risk cannot be taken by a private investor, because future river runoff is beyond his power. The public sector should take over this risk.	
Design and Construction Risk	The risk can be taken by a private investor, because unforeseeable natural conditions are marginal in power station construction.	The risk can hardly be hedged by a private investor, because unforeseeable natural conditions are significant in weir and tunnel construction.

Source: Study Team

From the above table, this paper concludes that the PPP business scheme should meet the following states.

- The power station component can be developed by the private sector, if the currency exchange risk is nicely mitigated.
- The non-power station components can hardly be developed by the private sector at his risk. The public sector should take the risk.
- Because of the different states above, a simple private investment mechanism, such as BOT or BOO, cannot be adopted.
- If one thinks about the maximum participation of the private sector, a possible PPP scheme may be a combination of i) BOT like private finance based development only for the power station component, ii) conventional public finance based development for the non-power station components, and iii) O&M Contract based daily operation and maintenance by the private sector.
- Finally, the DBFO (design-build-finance-operate) based hybrid business scheme, which can satisfy the above combination, can be the solution.

The financial analysis concludes that the DBFO Hybrid is the best fitting PPP scheme for the Simanggo-2 Hydropower Project. Table 14.4.3 summarizes the expected roles of the private and public sectors.

Table 14.4.3 Expected Tasks of Private and Public Sectors in PPP Scheme

	Private Sector Role (Power Station)	PLN Role (Non-Power Station)
Design Stage	PLN is fully responsible for planning to basic design, as one of the conventional PLN projects.	
Construction Stage	DBFO contractor procured by PLN is responsible for detailed design, construction, and finance for the power station.	PLN develops the non-power station. At the same time, PLN supervises the DBFO performances.
Operation Stage	DBFO contractor operates and maintains all of the project components including the non-power station, based on the contract with PLN. Payments to DBFO contractor should be on cost-plus-fee basis and not be like a conventional PPA, which is directly linked with electricity actually generated.	

Source: Study Team

Table 14.4.5 attempts to divide the interest free cash flow (Table 14.3.6) into two; one for PLN as the project owner representing the public sector, and the other is for a DBFO contractor as the private sector. Here, the following assumptions were made:

- The PPP Scheme is a DBFO based Hybrid (vertical separation).
- CAPEX is divided into US\$126.3 million for the non-power station portion (the public sector portion) and US\$83.1 million for the power station portion (the private sector portion), as detailed in Table 14.4.4.
- The payments from PLN can bring reasonable profit to the DBFO contractor. 13% of FIRR is assumed for the private sector portion.
- All of the daily operation and maintenance work for entire project facilities will be worked by the DBFO contractor.
- The DBFO contract period is 28 years being composed of 3 years of construction and 25 years of commercial operation. Upon expiration of the contract, PLN will become a sole project-operating entity.
- Both sectors will fulfill tax obligations.

Table 14.4.4 Assumption of Public-Private Cost Demarcations

US\$M					
Private Sector Portion	FC	LC	Total	FC	LC
Penstock, Powerhouse, Tailrace, Switchyard	0.54	3.78	4.32	12.6%	87.4%
Metal & Hydro-mechanical Works	7.63	3.27	10.90	70.0%	30.0%
Generating Equipment	40.41	4.49	44.90	90.0%	10.0%
Transmission Lines	0.41	0.14	0.55	75.0%	25.0%
VAT	0.00	6.07	6.07	0.0%	100.0%
Contingency	4.90	1.77	6.67	73.4%	26.6%
Price Escalation	3.96	5.75	9.72	40.8%	59.2%
Total	57.86	25.27	83.13	69.6%	30.4%
US\$M					
Public Sector Portion	FC	LC	Total	FC	LC
Total Construction	81.80	127.65	209.45	39.1%	60.9%
Less Private Items	-57.86	-25.27	-83.13	69.6%	30.4%
Total	23.95	102.38	126.32	19.0%	81.0%

Source: Study Team

The DBFO Hybrid scheme will yields a moderate return to the public sector e.g., FIRR = 8.4%. Since this return rate is greater than the hurdle rate and therefore the DBFO based PPP Scheme can be one of the feasible business scheme alternatives, as far as the Indonesian legislation allows it. If the DBFO based PPP business scheme is sought, careful administrative set-up is required such as for preparation of the business contract and procurement procedures. No matter what business scheme is chosen, it is of paramount importance that there exists a single responsible entity (the project owner), who is to control the entire project from the planning to the operating stages, to overcome the hydropower specific natural condition risks.

Note that, according to the trial analysis by the Study Team, an IPP based development of the project is not highly recommended. This is not only because the hydropower specific risk is high as discussed in Table 14.4.2, but because the expected return (a return on equity) will not satisfy the investor's requirement, e.g., ROE = 10.6% and $NPV_E = \text{US\$}5.8 \text{ mill}$. This financial analysis does not recommend the IPP business scheme for the Simanggo-2 Hydropower Project.

Table 14.4.5 PPP Financial Streams under DBFO Hybrid

Public Sector							US\$ mill.					Private Sector					US\$ mill.				
Year	CAPEX	OPEX	PPP	Tax	Benefit	Net	CAPEX	OPEX	Tax	PPP	Net	CAPEX	OPEX	Tax	PPP	Net	CAPEX	OPEX	Tax	PPP	Net
2011	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2012	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2013	2.02	0.00	0.00	0.00	0.00	-2.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2014	17.72	0.00	0.00	0.00	0.00	-17.72	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2015	52.92	0.00	0.00	0.00	0.00	-52.92	2.50	0.00	0.00	0.00	-2.50	41.86	0.00	0.00	0.00	-41.86	38.77	0.00	0.00	0.00	-38.77
2016	47.53	0.00	0.00	0.00	0.00	-47.53	0.00	5.61	3.42	22.30	13.27	0.00	5.79	3.37	22.30	13.14	0.00	5.98	3.32	22.30	13.00
2017	6.13	0.00	0.00	0.00	0.00	-6.13	0.00	6.17	3.28	22.30	12.85	0.00	6.17	3.28	22.30	12.85	0.00	6.17	3.28	22.30	12.85
2018	0.00	0.00	22.30	5.85	37.79	9.64	0.00	6.37	3.23	22.30	12.70	0.00	6.37	3.23	22.30	12.70	0.00	6.37	3.23	22.30	12.70
2019	0.00	0.00	22.30	5.92	38.05	9.83	0.00	6.58	3.17	22.30	12.54	0.00	6.58	3.17	22.30	12.54	0.00	6.58	3.17	22.30	12.54
2020	0.00	0.00	22.30	5.98	38.31	10.03	0.00	6.80	3.12	22.30	12.38	0.00	6.80	3.12	22.30	12.38	0.00	6.80	3.12	22.30	12.38
2021	0.00	0.00	22.30	6.05	38.57	10.22	0.00	7.03	3.06	22.30	12.21	0.00	7.03	3.06	22.30	12.21	0.00	7.03	3.06	22.30	12.21
2022	0.00	0.00	22.30	6.11	38.83	10.42	0.00	7.26	3.00	22.30	12.03	0.00	7.26	3.00	22.30	12.03	0.00	7.26	3.00	22.30	12.03
2023	0.00	0.00	22.30	6.18	39.10	10.62	0.00	7.51	2.94	22.30	11.85	0.00	7.51	2.94	22.30	11.85	0.00	7.51	2.94	22.30	11.85
2024	0.00	0.00	22.30	6.25	39.37	10.82	0.00	7.76	2.88	22.30	11.66	0.00	7.76	2.88	22.30	11.66	0.00	7.76	2.88	22.30	11.66
2025	0.00	0.00	22.30	6.31	39.64	11.02	0.00	8.03	2.81	22.30	11.46	0.00	8.03	2.81	22.30	11.46	0.00	8.03	2.81	22.30	11.46
2026	0.00	0.00	22.30	6.38	39.91	11.23	0.00	8.30	2.74	22.30	11.26	0.00	8.30	2.74	22.30	11.26	0.00	8.30	2.74	22.30	11.26
2027	0.00	0.00	22.30	6.45	40.18	11.43	0.00	8.59	2.67	22.30	11.04	0.00	8.59	2.67	22.30	11.04	0.00	8.59	2.67	22.30	11.04
2028	0.00	0.00	22.30	6.52	40.46	11.64	0.00	8.88	2.60	22.30	10.82	0.00	8.88	2.60	22.30	10.82	0.00	8.88	2.60	22.30	10.82
2029	0.00	0.00	22.30	6.59	40.74	11.85	0.00	9.19	2.52	22.30	10.59	0.00	9.19	2.52	22.30	10.59	0.00	9.19	2.52	22.30	10.59
2030	0.00	0.00	22.30	6.66	41.02	12.06	0.00	9.52	2.44	22.30	10.34	0.00	9.52	2.44	22.30	10.34	0.00	9.52	2.44	22.30	10.34
2031	0.00	0.00	22.30	6.73	41.30	12.27	0.00	9.85	2.36	22.30	10.09	0.00	9.85	2.36	22.30	10.09	0.00	9.85	2.36	22.30	10.09
2032	0.00	0.00	22.30	6.80	41.58	12.48	0.00	10.20	2.27	22.30	9.83	0.00	10.20	2.27	22.30	9.83	0.00	10.20	2.27	22.30	9.83
2033	0.00	0.00	22.30	6.87	41.87	12.70	0.00	10.56	2.18	22.30	9.56	0.00	10.56	2.18	22.30	9.56	0.00	10.56	2.18	22.30	9.56
2034	0.00	0.00	22.30	6.94	42.15	12.91	0.00	10.94	2.08	22.30	9.27	0.00	10.94	2.08	22.30	9.27	0.00	10.94	2.08	22.30	9.27
2035	0.00	0.00	22.30	7.01	42.44	13.13	0.00	11.34	1.98	22.30	8.98	0.00	11.34	1.98	22.30	8.98	0.00	11.34	1.98	22.30	8.98
2036	0.00	0.00	22.30	7.09	42.73	13.35	0.00	11.75	1.88	22.30	8.67	0.00	11.75	1.88	22.30	8.67	0.00	11.75	1.88	22.30	8.67
2037	0.00	0.00	22.30	7.16	43.03	13.57	0.00	12.18	1.77	22.30	8.35	0.00	12.18	1.77	22.30	8.35	0.00	12.18	1.77	22.30	8.35
2038	0.00	0.00	22.30	7.23	43.32	13.79	0.00	12.62	1.66	22.30	8.01	0.00	12.62	1.66	22.30	8.01	0.00	12.62	1.66	22.30	8.01
2039	0.00	0.00	22.30	7.31	43.62	14.01	0.00					0.00					0.00				
2040	0.00	0.00	22.30	7.38	43.92	14.23	0.00					0.00					0.00				
2041	0.00	0.00	22.30	7.46	44.22	14.46	0.00					0.00					0.00				
2042	0.00	0.00	22.30	7.53	44.52	14.69	0.00					0.00					0.00				
2043	0.00	13.09	0.00	6.93	44.83	24.81	0.00					0.00					0.00				
2044	0.00	13.57	0.00	6.88	45.13	24.68	0.00					0.00					0.00				
2045	0.00	14.08	0.00	6.83	45.44	24.53	0.00					0.00					0.00				
2046	0.00	14.61	0.00	6.78	45.75	24.37	0.00					0.00					0.00				
2047	0.00	15.16	0.00	6.72	46.07	24.19	0.00					0.00					0.00				
2048	0.00	14.14	0.00	0.00	0.00	-14.14	0.00					0.00					0.00				
2049	0.00	16.33	0.00	6.25	46.70	24.12	0.00					0.00					0.00				
2050	0.00	16.95	0.00	6.17	47.02	23.90	0.00					0.00					0.00				
2051	0.00	17.61	0.00	6.09	47.35	23.65	0.00					0.00					0.00				
2052	0.00	18.29	0.00	6.00	47.67	23.38	0.00					0.00					0.00				
2053	0.00	19.00	0.00	5.90	48.00	23.10	0.00					0.00					0.00				
2054	0.00	19.74	0.00	5.80	48.33	22.79	0.00					0.00					0.00				
2055	0.00	20.51	0.00	5.69	48.66	22.45	0.00					0.00					0.00				
2056	0.00	21.32	0.00	5.57	48.99	22.10	0.00					0.00					0.00				
2057	0.00	22.16	0.00	5.45	49.33	21.72	0.00					0.00					0.00				
2058	0.00	23.05	0.00	5.31	49.66	21.31	0.00					0.00					0.00				
2059	0.00	23.97	0.00	5.16	50.01	20.88	0.00					0.00					0.00				
2060	0.00	24.93	0.00	5.01	50.35	20.41	0.00					0.00					0.00				
2061	0.00	25.93	0.00	4.84	50.69	19.92	0.00					0.00					0.00				
2062	0.00	26.98	0.00	4.67	51.04	19.39	0.00					0.00					0.00				
2063	0.00	28.08	0.00	4.48	51.39	18.83	0.00					0.00					0.00				
2064	0.00	29.23	0.00	4.28	51.74	18.23	0.00					0.00					0.00				
2065	0.00	30.43	0.00	4.07	52.10	17.60	0.00					0.00					0.00				
2066	0.00	31.68	0.00	3.85	52.46	16.93	0.00					0.00					0.00				
2067	-56.16	32.99	0.00	17.65	52.82	58.33	0.00					0.00					0.00				
Total	70.16	533.81	557.50	313.16	2198.16	723.52	83.13	214.83	66.77	557.50	192.77	83.13	214.83	66.77	557.50	192.77	83.13	214.83	66.77	557.50	192.77
PV	83.83	8.40	114.26	35.34	224.89	-16.94	49.58	37.57	15.30	114.26	11.80	49.58	37.57	15.30	114.26	11.80	49.58	37.57	15.30	114.26	11.80
Annu	8.42	0.84	11.48	3.55	22.59	-1.70	5.33	4.04	1.64	12.28	1.27	5.33	4.04	1.64	12.28	1.27	5.33	4.04	1.64	12.28	1.27

Source: Study Team

FIRR = 8.42%

FIRR = 13.00%

PPP: DBFO payments from PLN to DBFO contractor.

Tax of the public sector includes 10% VAT for DBFO payment.

14.4.3 CONCLUSION OF BUSINESS SCHEME AND FINANCING PLAN

The financial analysis finally concludes that:

- The Simanggo-2 Hydropower Project will show a good financial profitability.
- The Simanggo-2 Hydropower Project should be developed as either a PLN project or a DBFO based Hybrid project.

CHAPTER 15 ENVIRONMENTAL STUDY

15.1 GENERAL

The environment study for Simanggo-2 was conducted for the selected project in the Chapter 9 as the subject for Pre-feasibility study. The environment study was conducted for advancement of the design accuracy of Pre-feasibility study. The study was carried out to identify if there is no “irreversible environmental negative impact “through field observations, literacy reviews and interviews to the related people.

The definition of “irreversible environmental negative impacts” is considered as follows;

- Unexpected large scale involuntary resettlement will be necessary
- Identification of many endangered species in the condition where any appropriate mitigation measures could not established (ex. “Key species “ such as large scale mammals are occurred in the site and their habitat will be destroyed by the project, in addition, they could not find any forest body which has roles for evacuation corridor to another areas)
- Identification of vulnerable group such as indigenous people or minorities who might be affected

The environmental study was conducted based on sub-contract base during middle of October to middle of November. The environmentalists of JST joined the field observation and they gave necessary suggestions to them.

15.2 ENVIRONMENTAL SCOPING

15.2.1 PRELIMINARY FINDINGS FOR SIMANGGO-2

The preliminary findings for Simanggo-2 based on the field reconnaissance conducted in the process of the selection of priority project site are as follows.

(1) Intake

- No residential houses were identified.
- No cultivation area around the intake point.
- Secondary forests were observed around the site.
- Rock was exposed along the river, therefore geologically very stable.

(2) Power House

- There are five houses and small scale paddy land at the opposite site of the PH site. But relocation will not be necessary, because those are located outside of the construction area. Further examination shall be conducted, however, the negative impacts on the area would be quite limited based on the site observation.
- The access road to the PH site from the existing road will be necessary. However no residential houses were identified for which relocation would be required.

(3) General Comments

- The length of the section of water recession is approximately 7.8km.
- There are narrow path to the intake point on the left bank of the river.
- Small scale cultivation areas and grazing land were found along the path. Negative impacts on the area shall be further examined.



Photo 15.2.1 View of the intake point from 1km downstream



Photo 15.2.2 View of the PH site from the existing road

15.2.2 PRELIMINARY ENVIRONMENTAL SCOPING

Based on the findings during field reconnaissance, the preliminary environmental scoping was conducted. Environmental scoping for Simanggo-2 is shown in Table 15.2.1.

Table 15.2.1 Environmental Scoping for Simanggo-2

Item	Stage	Rating	Description
Social Environment			
Involuntary Resettlement	P	B-	Involuntary resettlement at the proposed sites of intake and powerhouse site is not expected. There is a possibility of involuntary resettlement due to expand of existing road for access road though its impact is considered as not significant.
Daily life of people in surrounding areas	C	C	Some temporal impact is expected on the people in surrounding area due to noise and vibration caused by the construction activities. On the other hand, positive impact such as improvement of convenience due to expansion of road is expected. However, impact to local people on their water use and land use is unknown at this stage.
Local economy such as employment and livelihood, etc.	C	C	Employment opportunity might be increased due to the project implementation, and improvement of transportation condition will be improved due to arrangement of access road. On the other hand, there might be some negative impact to local economy due to land acquisition of agricultural land by project implementation.
Land Use	C,O	C	The water intake and power house of the Project will not disturb existing land use. However, the present status of land use of the section of water recession (L: approx. 7.8km) was not confirmed.
Physical community division	-	D	Physical community division is not expected due to project implementation including access road construction.
Existing social infrastructures and services	C,O	C	There is no social infrastructure and service at the point of water intake and power house. However, the present status of social infrastructures and services in the section of water recession (L: approx. 7.8km) was not confirmed.
The poor, indigenous and ethnic people	C,P,O	C	It seemed that no ethnic minority lived around the project site. However, further examination on the poor, indigenous and ethnic people through socio-economic study will be necessary.
Misdistribution of benefit and damage	-	D	Misdistribution of benefit and damage is not expected.
Local conflict of interests	-	D	Local conflict of interests due to project implementation is not expected.
Water Usage or Water Rights and Rights of Common Sanitation		C	Water use of Simanggo River could not be confirmed in the field survey. So, further confirmation is necessary.
	C	B-	Some negative impacts on the local sanitary condition are expected, due to the mobilization of construction work force and/ or workers' site camps, although the expected impacts will be temporary during the construction stage.
Hazards (Risk), Infectious diseases	C	B-	Increment of risks are probably expected on infectious diseases among the construction work force and/ or in the workers' site camps, although the risk increment will be temporary during the construction stage.
Cultural Heritage	-	D	Cultural heritage is not located in/near the project site.
Natural Environment			
Topography and Geographical features	-	D	Topographical condition is stable, and therefore negative impact to topography and geographical features is not expected.
Soil Erosion	C	B-	There is a risk of soil erosion due to cutting and embankment.
Groundwater	C,O	B-	There is a risk of recession of groundwater level due to construction of tunnels.
Hydrological		B-	It is expected that the project component or activity might cause some

situation			change or impacts on hydrological conditions in and around the Project area.
Coastal Zone	-	D	There is no impact to coastal zone.
Flora, Fauna and Biodiversity	C,O	C	According to IUCN classification, there are some possibilities of occurring of endangered species in and around the Project area. In addition, there is a possibility that generation of water recession section might affect aquatic environment though its impact level is unknown at the current study level. Therefore, further confirmation is necessary.
Meteorology	-	D	It is not expected that the Project will cause the significant change on the regional meteorological condition.
Landscape	C,O	B-	Landscape will be changed in a certain extent due to construction of necessary facility and transmission line.
Global Warming	C	B-	Probability of increment of GHG emission is expected due to the operation of heavy vehicles as well as traffic jam incidental to the construction works at the construction stage. As for the operation stage, increment of GHG emission would be expected related to operation and maintenance works of facilities though its impact would not be serious.
Pollution			
Air Pollution	C	B-	Some negative impacts on air quality are expected due to operation of heavy equipment/ vehicles as well as traffic jam incidental to construction works, although the expected impacts will be temporary during the construction stage.
Water Pollution	C	B-	There is a risk of temporal water pollution due to excavation and cutting as well as wastewater discharge from worker's camp during construction. In addition, water pollution due to generation of water recession section might be occurred at the operation stage.
Soil Contamination	-	D	Soil contamination due to project implementation is not expected.
Waste	C	B-	There is a possibility that the construction work generates the construction waste in the construction stage.
Noise and Vibration	C	B-	Temporal impact of noise and vibration during construction are expected.
Ground Subsidence	-	D	There is no activity which causes ground subsidence.
Offensive Odor	-	D	There are no project components or activities which may cause the offensive odor.
Bottom Sediment	C	B-	Although there is no activity to generate some impact to bottom sediment, there might be some risk to downstream area due to flushing bottom sediment.
Accidents	C	B-	There is a risk of accidents during construction work and transportation of heavy vehicles.

Project Stage

P: Planning C: Construction O: Operation

Legend of Evaluation

A-: Serious impact is expected.

A+: Positive effect is expected.

B-: Some impact is expected.

B+: Positive effect is expected to a certain extent.

C-: Extent of impact is unknown. Further examination would be necessary. Impact may become clear as study progresses.

D: No or negligible impact is expected. Further examination is unnecessary in EIA study.

Source: JICA Study Team

15.3 ENVIRONMENTAL STUDY

15.3.1 STUDY ITEMS

The study items were as follows. The confirmation of the present conditions was conducted focusing on those items which were evaluated as “B” or “C” in the environmental scoping.

(1) Social Environment

- 1) Socio-economic condition
- 2) Land use
- 3) Water use
- 4) Groundwater use
- 5) Consciousness of the project

(2) Natural Environment

- 1) Confirmation of flora and fauna
- 2) Confirmation of forest classification

Items such as sanitation, infectious diseases, landscape, and global warming are excluded from the study items, although evaluated as “B” or “C”. These items shall be examined in further stage of EIA.

15.3.2 METHDOLOGIES AND SUBJECT AREAS

(1) Methodologies

1) Social Environment

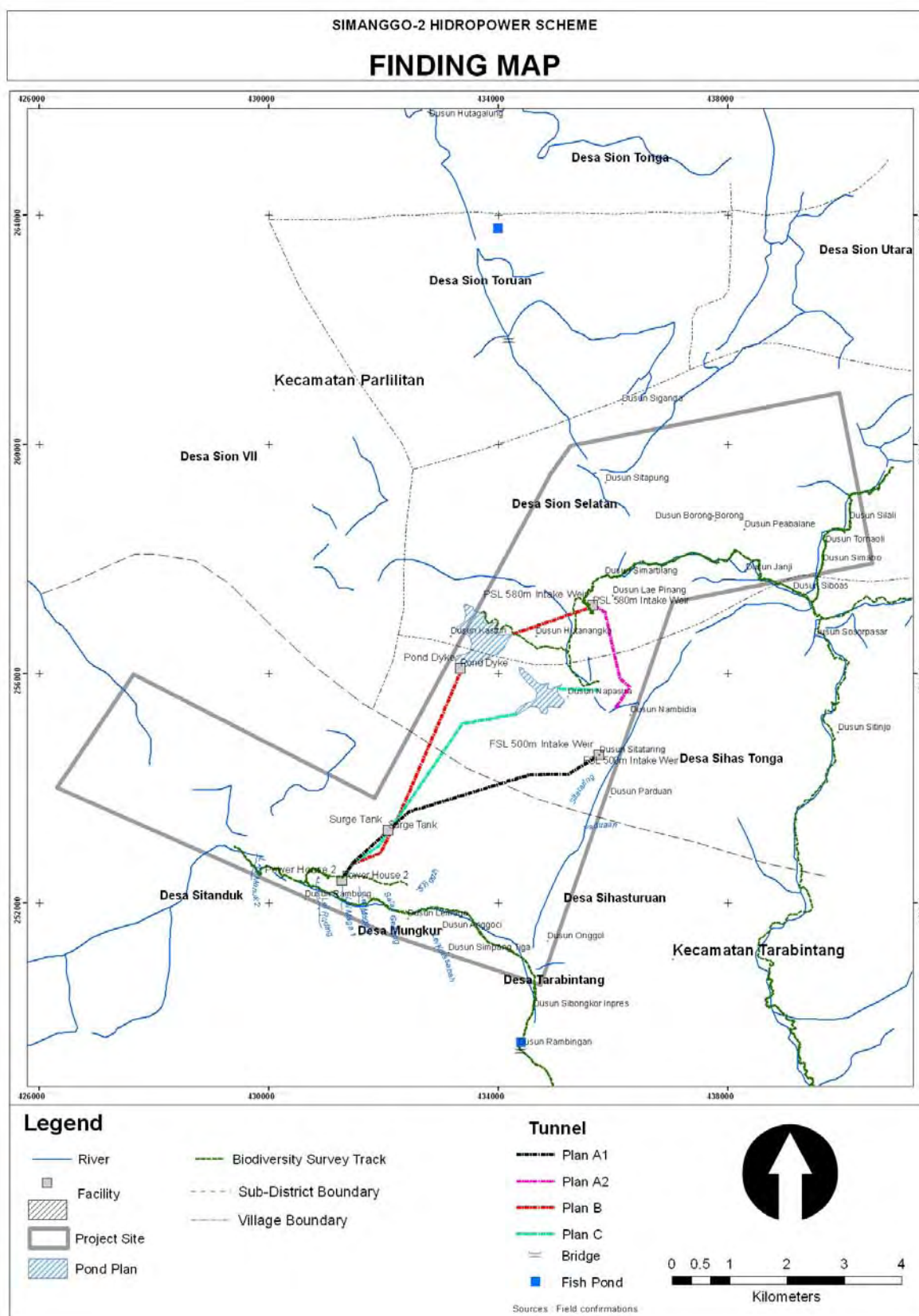
Water and land use along the Simanggo river and its branches were observed by visual check in case that accessibility to the site was confirmed. In the case of difficult accessibility to the site, interview to local people was conducted to confirm the area. The same method was applied for the confirmation of land use and possibility of household relocation at the candidate area of permanent and temporal facilities. As for confirmation of prospects to the project, interview to the limited local people such as village leaders and key persons in a village as the representative of villagers was held by considering current study level and local custom.

2) Natural environment

Based on the observation route which was examined in advance, the field observation was conducted. The flora and fauna was observed by basically by sight. Fauna were examined by the books of references also. In addition, interviews to local people were conducted to add information for present condition of flora and fauna. Several samples for flora were took back to Jakarta to confirm the species accurately.

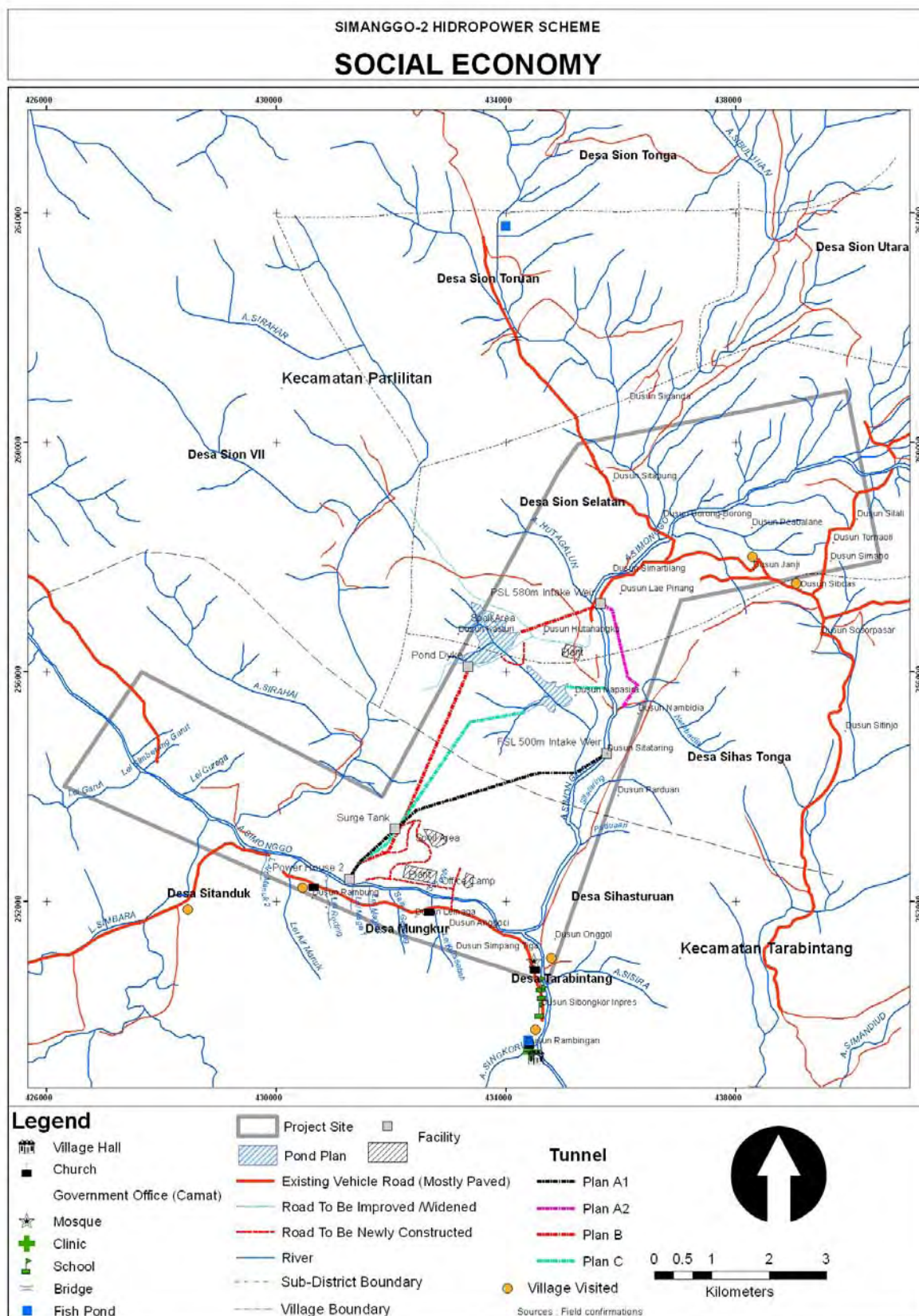
(2) Study Area

The subject area for the study and observation route is shown in the Figure 15.3.1.



Source: JICA Study Team

Table 15.3.1 Study Area and Observation Route



Source: JICA Study Team

Table 15.3.2 Villages Visited during Site Confirmation

15.3.3 THE RESULTS OF THE STUDY

(1) Social environment

1) Present condition of the socio-economic¹

Simanggo-2 project site locates in five villages in two districts at Tarabintang and Palilitan Regencies of North Sumatra Province as described in the Table 15.2.1.

Table 15.3.1 Administrative Information at Each Village in the Project Area

(unit: ha)

Village/Regency	Area (ha)	People/Household	Density (People/Ha)	Average Household Population
Sitanduk/Tarabintang	6,100	1,826/365	30	5
Tarabintang/Tarabintang	5,840	1,343/269	23	5
Sihas Toruan/Tarabintang	4,171	790/220	19	4
Sihas Tonga/Parlilitan	1,800	2,289/485	128	5
Sion Selatan/Parlilitan	3,600	2,449/500	69	5

Source: Tarabintang and Parlilitan District Profile, 2008

Demographic information at each village in the project area is shown in the Table 15.3.2.

Table 15.3.2 Demographic Information at Each Village in the Project Area

(unit: people)

Village/Regency	Total Population	Sex			
		Male	%	Female	%
Tarabintang (Regency)					
Sitanduk	1,826	921	50,44	905	49,56
Tarabintang	1,343	657	48,92	686	51,08
Sihas Toruan	790	381	48,23	409	51,77
Parlilitan (Regency)					
Sihas Tonga	2,289	1,098	47,97	1,191	52,03
Sion Selatan	2,449	1,220	49,82	1,229	50,18

Source: Tarabintang and Parlilitan District Profile, 2008

2) Ethnic Distribution and Religion

The majority ethnic group at the project area is Batak, especially sub-groups of Batak Dairi and Batak Toba. The minority ethnic groups in this area are Nias, Banjar, and Java. The common language among ethnic groups is the language of Batak Toba group. More than 80% of this area is Christian following Catholic about 15% and Muslim about 5%. Although there are several ethnic groups with different religions, conflict between each group was not confirmed since the life of this area is based on the concept of “Dalihan Natolu”. This is, all ethnic groups bound in a single kinship and brotherhood with mutual respect and appreciation to the traditional culture.

¹ Desa Mungkur was part of Desa Sitanduk until December 2010, and became a village (desa) in January 2011. Thus, all baseline data of Desa Mungkur was included into Desa Tarabintang in this report.

3) Administrative Structure

A village (*Desa*) has a village leader, and is composed of several sub-village (*Dusun*). Each sub-village has a traditional or customary leader, namely *Raja Huta* who is hereditary and selected based on the historical background. *Raja Huta* has the authority in the wide range of sub-village management such as land tenure, security, economy and politics. *Raja Huta* has sometimes much effective than a village leader.

4) Economic Activity

The major economic activity in the project area is agriculture mainly rice cultivation and plantation, which are main income source for local people. The cultivated area at each village is shown in the Table 15.3.3. In addition, livestock farming is held for their additional income. The average income at the project area is calculated as approximately Rp.1,400,000/household/month at Sitanduk, Rp.1,600,000/household/month at Tarabintang, Rp.2,200,000/household/month at Sihas Tonga, Rp.800,000/household/month at Sihas Tonga and Rp.1,300,000/household/month at Sion Hudon Selatan against the regulated minimum wage as Rp.965,000 per month in 2008, by referring the household income data in Tarabintang and Parlilitan District Profile, 2008. In addition to the statistic data, it was observed from the interview to village leaders and key persons as well as visual check of livelihood in a village that economic condition at the study area might be poor to slightly middle level despite of limited persons.

Table 15.3.3 Cultivated Area at Each Village in the Project Area

(unit: ha)

Villages/District	Ricefield	Rubber	Coffee	Cocolate	Kemenyaan	Total
Sitanduk/Tarabintang	104.3	463	4	16	0	6.100
Tarabintang/Tarabintang	169.5	558	3	13	0	5.840
Sihas Toruan/Tarabintang	194.2	452	2	6	0	
Sihas Tonga /Parlilitan	210.0	434	98	6	63.8	3.600
Sion Selatan /Parlilitan	70.0	0	102	3	61.2	2.200

Source: Tarabintang and Parlilitan District Profile, 2008

5) Cultural Heritage

According to the inventory report of cultural heritage issued by the authority for heritage maintenance at North Sumatra province in 2009, no cultural heritages were recorded in the study area. According to the interview to village key person, however, there might be the cultural relic called *Gurih-gurih* in each village, which is established for appreciation to ancestors. The relic was not observed during site confirmation, and interviewees did not know its location in the villages. An example of *Gurih-gurih* is shown in the Photo 15.3.1.



Source: Taken in 2008 by Local Consultant, CONNUSA

Photo 15.3.1 Example of *Gurih-Gurih*

6) Public Infrastructure

The area has public facilities listed in Table 15.3.4. Although relocation of public facility due to project implementation may not occur, there found some churches and schools in the study area especially along or close to the main road in villages.

Table 15.3.4 Public Infrastructure at Each Village in the Project Area

Facilities	Tarabintan			Parilitan	
	Sitanduk	Tarabintang	Sihas Toruan	Sihas Tonga	Sion Selatan
1. Education					
a) Elementary school	3	4	2	1	4
b) Junior high school	1	1	-	1	1
c) Senior high school	-	-	-	-	-
2. Health					
a) Local government clinic	-	1	-	-	-
b) Unit local government clinic	-	-	-	1	1
c) Integrated Public Services	3	3	3	1	2
3. Centre for Religions Work ship					
a) Mosque	2	5	-	-	-
b) Church	11	9	5	4	14

Source: Tarabintang and Parilitan District Profile, 2008

7) Present condition of the land use

The project area stretches over protection forest (Hutan Lindung) and production forest (Hutan Produksi) in the administrative land use classification. Although the classified forest area is defined its land use according to the relevant regulations as mentioned in the Chapter 5, the actual condition of the protection forest in the study area is the mixed forest including plantation and small scale sporadic paddy field as shown in the land use map shown in . Land use of particular area in the study area is shown in the Table 15.3.5.

Table 15.3.5 Land Use at Particular Area

Facility Construction Plan	Necessary Area (ha)	Confirmed Land Use	Expected No. of Displaced Household (HH)	Location (village name)
Intake	1.7	- Mixed forest	0	Sion Selatan
Regulation Pond	14.4	- Paddy field - Mixed forest - Plantation (rubber)	0	Sion Selatan
Powerhouse	1.1	- Secondary forest - Plantation (rubber, durian)	0	Mungkur
Spoil Bank	8.0	- Plantation	0	Mungkur
Office/ Plant	1.8	- Plantation	0	Mungkur
Construction Road	7.2	- Secondary forest - Plantation - Paddy field	0	Sion Selatan Sihas Tonga Mungkur

Source: JICA Study Team



Figure 15.3.3 Land Use at Study Area

8) Land Ownership

Protection forest and production forest are defined as public land, and local people are the forest user. However, protection forest and production forest in the study area are recognized as community land for local people, according to the interview to key persons. Local people appeared not to have any consciousness to protection forest.

According to the interview result, at least four parties such as *Raja Huta*, a village leaders land users and a project proponent will be involved in the land acquisition in this area. Following procedure will be necessary. First of all, a project proponent explains a project plan to *Raja Huta*. Secondly, *Raja Huta* consults with a village leaders and key persons in a village, and conducts a field study if a plan is agreed. Thirdly, *Raja Huta* consults with land users to be affected by a project on land acquisition procedure and compensation by inviting a village leader and key persons as witnesses. Fourthly, a meeting among *Raja Huta*, a village leader, land users and a project proponent is held to confirm land acquisition procedure and compensation. Fifthly, all decision on land acquisition is disclosed with a project plan to all villagers in a village. Finally, land lease form (*Surat Sakti*) is issued by *Raja Huta*.

9) Present condition of the water use

Water use of Simanggo river was confirmed at three sections; i) from 3km upstream of the intake area up to the intake area, ii) water recession section, and iii) powerhouse to 5km downstream from powerhouse. Water at upstream section was used for irrigation to lowland paddy field close to the Simanggo river and fishing for daily consumption. According to local people, fish caught at upstream section would be used for ceremonial purpose as well as sold at the market. Water use at water recession sections was occasional fishing for domestic consumption and supplemental income. However, it was used for drinking, bathing and toilet only when local people stayed near the Simanggo river for whole day of working though general water source for local people near the Simanggo river was from branches flowing into the Simanggo river. Regarding downstream section, local people used Simanggo river for occasional fishing to their domestic consumption and supplemental income but did not use for paddy field due to difficult accessibility. Although some local people fishing for their domestic consumption and/or supplemental income were confirmed at the entire study area, professional fishery and/or leisure activity such as rafting were not observed.

There were several branches in the study area, and all of them were inflow to Simanggo river. Three major branches; Hutagalung river at upstream area, Leirambe river at water recession section and Lei Napsingkam river at the downstream area were observed. In addition, there were eleven small branches flowing into the Simanggo river. According to local people, water use of these rivers was irrigation, fishing, bathing and drinking water.

10) Present condition of the groundwater use

No groundwater use was confirmed.

11) Consciousness of local people for the project

Interview with village leaders and key persons were held at each village in the project area. Villages visited and interviewees list during field observation, and photos of interview are enclosed in Appendix 2. The following questions were mainly discussed at each interview.

- a) Agree/disagree to the project
- b) Prospects to the project
- c) Water use in the project area
- d) Socio-economic condition in a village
- f) Particular culture in a village
- g) Practices on land acquisition procedure in a village

Opinions obtained from the discussion at the project area were outlined below.

- a) The project area does not have sufficient traffic access to the regional central area, and therefore the area is isolated. The proposed project is considered to be the milestone for the regional development of the area. Therefore, proposed project is considered as supportive.
- b) Several previous projects, especially infrastructure development or facility supporting projects, despite of governmental or private projects were supported by the area since they provided benefits to the area. The proposed project might provide benefits to the area, and therefore the proposed project might be welcomed.
- c) It is important and necessary to involve local people in the decision making process of the proposed project for smooth implementation of the project.
- d) It is considered that the project has a potential to provide job opportunities to the local people.
- e) Land acquisition shall follow the local procedure.
- f) At the small hydro project, Simanggo-1 project, located near the Simanggo-2 project area, some local people were not supportive to the project because they felt they were not involved into the project. In addition, there were some people who misunderstood the project (i.e., impact caused by project implementation) due to inappropriate or incorrect information.

12) Summary of the Social Environment

- 17.2ha of land in total is necessary for construction of permanent facilities such as intake,

regulation pond and powerhouse. In addition, 17ha of land in total is necessary for construction of temporal facilities such as spoil bank, office/plant and construction road. Main land use of these area is secondary forest, paddy field and plantation (rubber and durian). Although land acquisition might be required, involuntary resettlement is not expected.

- Project area is isolated from the central area in a village, and transportation connection within a village is not convenient. Economic level in this area is considered as low.
- Professional inland fishery and local people who depended their livelihood on the Simanggo river were not observed during site confirmation. However, there found some people fishing at Simanggo river for their domestic consumption, supplemental income and/or pleasure.
- Main income source of the study area is agriculture such as rice cultivation and plantation. Although land acquisition at some area in paddy field and plantation will be required, it will not be large area. Thus, impact to mean of livelihood for local people due to project implementation would be probably not serious.
- Local people expect improvement of economy and traffic connection by the project implementation.
- It was found from the interview to village leaders and key persons that Simanggo-1 project locating upstream of Simanggo-2 had a conflict with some of local people to implement since they felt not involved in that project. For smooth implementation, sufficient public involvement and participation is indispensable.
- Education level of local people is not necessarily high. If local people had incorrect information or misunderstanding to a project, such situation might cause project implementation difficult due to unsupportive attitude of local people. Thus, appropriate information disclosure by simple explanation is indispensable.

(2) Natural Environment

1) Present Condition of Flora

Ecosystem types in the area of hydropower development plans Simanggo-2 can be divided into five types, namely:

a) Primary forest with secondary growth



Source: JICA Study Team

This type of ecosystem with plain physiography to undulating and hilly is found at the propose site of Plan C Intake and Control Pond. The dominant tree species are *Durio zibethinus*, *Styrax benzoin*, *Bridelia glauca*, *Litsea machilifolia* etc.

b) Secondary forest



Source: JICA Study Team

This ecosystem was found at the Power House site. where the phisiographical characterists is flat land to undulating. The dominant tree speices are *Durio zibethinus*, *Hevea brasiliensis*, *Styrax benzoin* , *Parkia speciosa*, *Vitex pinnata*, *Litsea machilifolia* etc.

c) Agro-forests



Source: JICA Study Team

This type consisting of a mixture of economically important species of plants with forests vegetation is on the slope with some points that have hilly physiography. Elevation ranges from 600-700 m above sea level. The types was found as the location of the site spoil area of Plan B. The dominant tree species are *Durio zibethinus*, *Hevea brasiliensis*, *Styrax benzoin* *Trichospermum javanicum* etc.

d) Mix Cultivation and garden



Source: JICA Study Team

This type consists of paddy fields cultivating rice (*Oryza sativa*) in flat or terraced land with crops of cassava (*Manihot esculenta*), rubber, banana, etc. Garden plants around the house usually planted economical crops such as: cocoa (*Theobroma cacao*), coconut (*Cocos nucifera*), rambutan (*Nephelium lappaceum*), papaya (*Carica papaya*), banana (*Musa spp.*), etc.

e) Open Land & Shrubs-grove

This type consists of *Imperata cylindrica*, *Gleichenia linearis*, *Pteris spp.*, etc.



Source: JICA Study Team

Number of vegetation species found in the study sites is 44 species of tree and 72 species of others including palms, bamboos, lianas and climber, herbs, grasses and shrubs (refer to 15.1 in Appendix 2).

Among of them there are 3 species that have been included endangered according to IUCN , namely: *Shorea bracteolata* Dyer; *Shorea dasyphylla* Foxw and *Shorea faguetiana* Heim. (Dipterocarpaceae).

2) Present Condition of Fauna

The total number of species of fauna including mammals, birds, reptiles, and amphibians found at the sites were 88 species. (refer to 15.2-4 in Appendix 2)

a) Mammals

18 species of wildlife mammals found. Out of 18 species, 13 species were found in the primary forest with secondary growth. This indicates that primary forest ecosystem has a tendency as a better habitat for various wildlife species of mammals.

The following four species are included in the category of vulnerable according to IUCN .



Source: JICA Study Team

- Macaca fascicularis
- Macaca nemestrina
- Aonyx cinerea
- Sus barbatus



Source: JICA Study Team

b) Birds

The number of bird species found is 55 species. Note that no species included in the category of “endangered” or “vulnerable” according to IUCN were identified.

Generally the bird species have high rate of vulnerability to habitat change. Especially in case of the bird species classified to inner-space species such as Ictinaetus malayensis, their eating behavior is mostly in open areas but they need relative dense canopy for nesting, breeding, and nursing.

c) Herpetofauna

The number of herpetofauna species of wildlife found with by direct observation and interview to local people is 15 species consisting of eight reptiles species and seven amphibian species.

Out of those identified species, the carcass of Heosemys spinosa (spiny turtle) was found. It is the reptile species which categorized as endangered according to IUCN.

d) Freshwater Fishes



Source: JICA Study Team

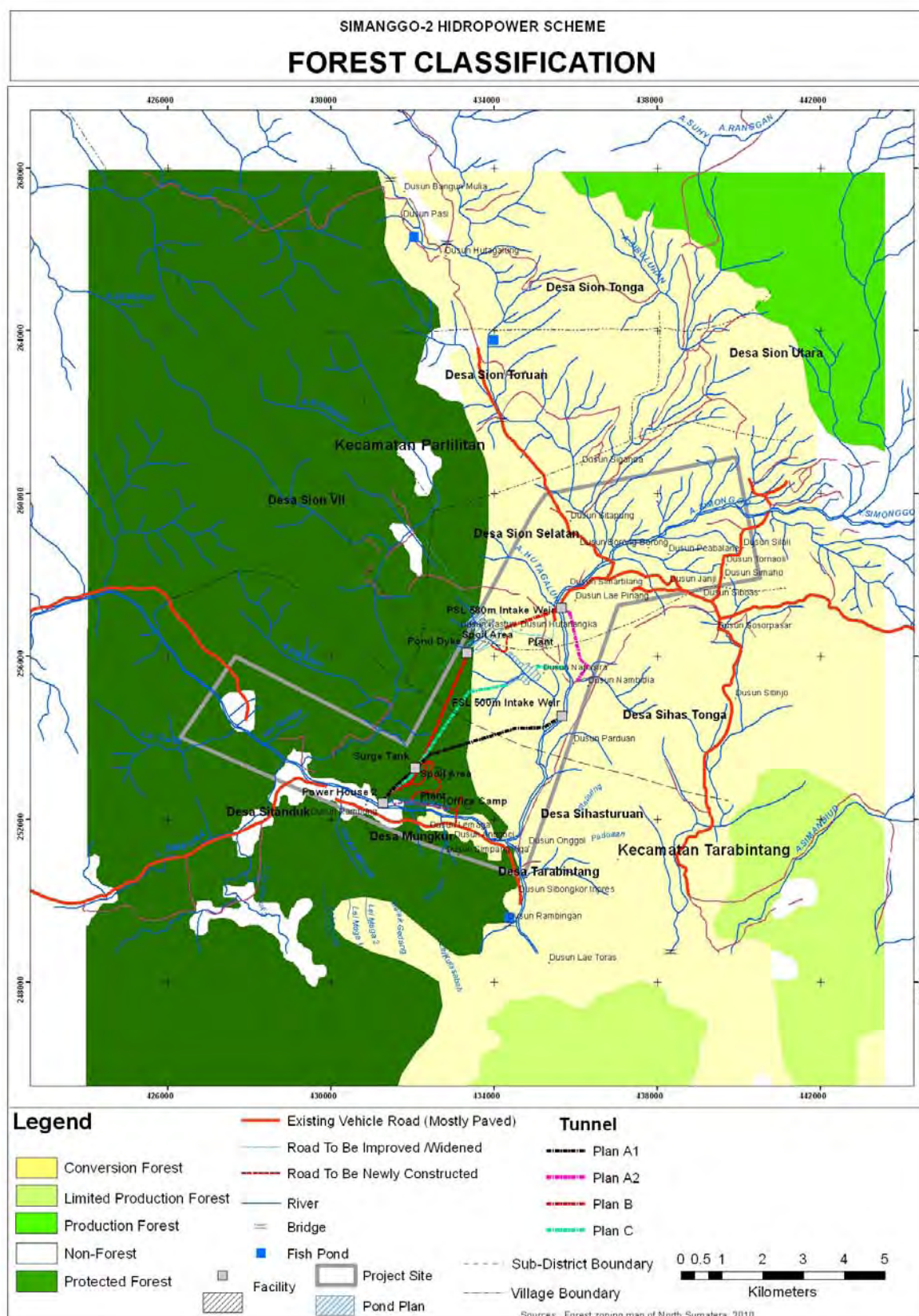
The common fish species found in running water of Simanggo River is fish species belongs to the family Cyprinidae and Gobiidae that correlation to its conditions of swift-flowing river waters and rocky bottom, where conditions such as these waters are preferred by the fish belong to the family of Cyprinidae and Gobiidae.

According to the secondary data based on the interview to local people, the fish species could be found in the Simanggo River are shown in 15.5 in Appendix 2.

Those species include the species for fish culture or selling at the local market such as: gold-fish (*Cyrinus carpio*), Mujair (*Oreochromis mossambicus*), Nila (*Oreochromis niloticus*), Tawes (*Puntius javanicus*), Lele dumbo (*Clarias garipienus*), etc.

4) Forest Classification

Forest classification for the study area is as shown in Figure 15.3.4. This figure indicates that the intake point is inside of limited production forest and the power house site is outside of any forest classification. Note that the control pond for Plan B will be located inside of protected forest.



Source: JICA Study Team

Figure 15.3.4 Forest Classification

15.3.4 EXAMINATION OF THE ALTERNATIVES

The basic concept of this study is to take environmental consideration into account for project planning in order to reduce environmental and social risks at technically and economically feasible level from the early stage of project planning. The following issues were mainly discussed in the course of layout designing.

- Location of permanent and temporal facilities shall be designed to avoid protection forest, residential area and cultivated area.
- Route of construction road shall be designed to avoid habitation and cultivated area.
- The route of transmission line shall be planned to avoid protection forest.

Based on the basic concept, alternative examination was made for intake and penstock location from environmental and social viewpoints in the course of selection of an optimal plan.

Regarding intake location, comparison among three alternatives namely Plan A, B and C was made qualitatively based on map study and field confirmation. The points and findings to be noted were summarized in Table 15.3.6 which were incorporated into the engineering design. Plan C is considered as slightly less negative impact to environmental and social aspects among three alternatives from the examination result.

Table 15.3.6 Comparison among Three Layout Alternatives

Plan A	Plan B	Plan C
- Total length of channel is the longest. - Secondary forest close to the natural condition was observed.	- Regulation pound locates in the Protection Forest. - Regulation pound was covered with mixed forest including scattered plantation.	- Water recession section is the shortest. - Secondary forest close to the natural condition was observed.

Source: JICA Study Team

With respect to penstock location, two alternatives, Plan A and B were examined by map study and site confirmation. From the examination result, Plan A is considered as less impact to environment than Plan B.

Table 15.3.7 Comparison of Penstock Location

Plan A (Underground Plan)	Plan B (Ground Plan)
- Small number of temporal construction road might be necessary. - Land acquisition and cutting tree might be minimized. - Temporal turbidity might occur during construction.	- Several temporal construction roads might be necessary. - Lots of trees might be necessary to be cut. - Relatively large area of land acquisition might be necessary for construction of permanent facilities and temporal construction roads. - Scenery might be disturbed due to construction of permanent facilities.

Source: JICA Study Team

15.3.5 DISCUSSION

(1) Procedure of Land Acquisition

As described in the 15.3.3, there was a conflict at a project, Simanggo-1. The lesson-learnt from this project is importance of public involvement and dissemination of adequate information to local people. Although positive and supportive comments were obtained from key persons at the site interview, there is a possibility that a conflict like Simanggo-1 might occurred if sufficient socialization was not held. Since the project will require some area regarded as community land for local people, socialization with local people including project affected persons in timely manner is necessary to go forward.

(2) Confirmation of Household Socio-Economic Condition

The project will require land acquisition at paddy field and plantation though necessary area is considered as small. Although acquired area is expected as small, it may cause a loss or reduce of livelihood means for local people. Same as land acquisition, the project also has a possibility to affect socio-economic and nutritional condition to those who obtain supplemental income and nutrition from fishes they caught due to generation of water recession section by project implementation though impact is considered as not significant based on the site confirmation and interview to key persons.

In order to examine appropriate compensation and necessary assistance for livelihood stabilization, impact caused by the project is necessary to be understood. For this purpose, detailed examination of socio-economic and nutritional condition on local people in the project area including confirmation of income source and property loss shall be done.

(3) Flora/Fauna

The following species of flora and fauna which categorized as endangered or vulnerable according to IUCN were found in the study at surround area of the site of Simanggo-2.

- Flora : "Endangered" 3 tree speicies of Dipterocarpaceae
- Fauna : "Endangered" 1species of reptile (Heosemys spinosa : identified in dead)
"Vulnerable"4species of Mammal (Macaca fascicularis, Macaca nemestrina, Aonyx cinerea and Sus barbatus)

The limited or selective tree cutting in the land clearing for the construction of project is indispensable to protect the "Endangered" tree species.

Regarding for identified endangered or vulnerable fauna species, the habitat characteristics of those species are as shown below.

Table 15.3.8 Habitation of Endangered Tree Species

Species	habitat characteristics
<i>Heosemys spinosa</i>	It inhabits lowland and hill rainforest, usually in the vicinity of small streams, mainly in hill areas up to 900 m.
<i>Macaca fascicularis</i>	<i>Macaca fascicularis</i> is found in a wide variety of habitats, including primary lowland rainforests, disturbed and secondary rainforests, and riverine and coastal forests of nipa palm and mangrove. They also easily adjust to human settlements. While a pest when around farms and villages.
<i>Macaca nemestrina</i>	<i>Macaca nemestrina</i> , omnivorous macaque, is mostly found in forest, but will also enter plantations and gardens.
<i>Aonyx cinerea</i>	<i>Aonyx cinerea</i> commonly could be found in freshwater wetland and meandering rivers. They also dominated irrigated rice fields and wandering in area between patches of reeds and river debris where many crab species were more likely to be found. They dislike bare and open areas that do not offer any shelter. Thus, they prefer pond areas and rice fields more than the rivers.
<i>Sus barbatus</i>	<i>Sus barbatus</i> inhabits rainforests and mangrove forests.

Source: JICA Study Team

As shown the above, the all species greatly rely on the existence of forest. Therefore, it is considered as effective mitigation measure to conserve the existing forest as much as possible. In order to minimize the negative impact caused by the project, the following mitigation measures are proposed.

- Restrict land clearing for the project, according to the minimum need
- Not interrupt the series of forest distribution to ensure the corridor for movement of fauna species
- Restrict and manage the use and control of access roads, to prevent logging and poaching
- Conduct reforestation on degraded forest areas in the vicinity of the location of Hydroelectric Power
- Implement local community empowerment program to prevent the extraction of forest surrounding the hydropower and water conservation in the upstream catchment area

(4) Amount of Stream Flow for Maintenance

The amount of stream flow for maintenance has been decided as 1.00m³/sec in this Pre-FS. Given that the Simanggo River will be joined with Rambe River at approximately 6km downstream of the intake in the water recession section of Simanggo-2 which is approximately 9km, substantial amount of river water will be inflow to the Simanggo River at the point of the river joint.

Maximum plant discharge	: 38.6 m ³ /s
River discharge	: 25.1m ³ /s in average、9.0 m ³ /s at 95% probability
Flow for maintenance	: 1.0 m ³ /s from intake weir
Water recession section	: 9km in total, confluence with Rambe River at 6km from the weir

Considering that several small tributaries up to the point of river joint are found, drawing river water at the intake will not cause serious negative impact on river environment. It has been already confirmed that there is no water use by irrigation and local people for dairy use in the water recession section in the environmental study.

(5) Procedures for Forest Use

As mentioned already, the project components are located inside limited production forest and protected forest. The following procedures for the forest use should be taken to use for development of infrastructure which not related with forestry activities.

1) Forest Use

The use of forest areas to development infrastructure which not related with forestry activities can only be done in the area of production forest and protected forest areas (Act No. 41 of 1999 Regarding Forestry). This means the conservation forest could be used only for forestry activities.

The Government Regulation (No. 24/2010) stipulates the use of forest areas to development infrastructure which not related with forestry activities. The development infrastructure includes installation of generators, transmission, and distribution of electricity, as well as new and renewable energy technologies.

a) Procedures for Forest Use

The use of forest areas is based on forest use permit approval by Ministry of Forestry. The application should be submitted by following person.

- a. ministers or ministerial-level officials;
- b. governor;
- c. regent / mayor;
- d. leadership of a business entity; or
- e. chairman of the foundation

In the case of this Project, MEMR will be applicant for the forest use. Given that the procedures of Ministry of Forestry will be take rather long time, it will be recommended to start the necessary actions as early as possible.

(6) Fluctuation of Water Level at Downstream of Powerhouse

Water level fluctuation at peak/off-peak power generation will occur at downstream of the powerhouse. It is confirmed in this study that there exists no irrigation intake within 5km distance downstream from the powerhouse. As a rather big river (Rembe River) joins with the Simanggo River at the water recession section, it is anticipated that the environmental impact due to water level fluctuation will not be serious. However, necessity of warning siren shall be examined in the further stage of the study.

15.3.6 CONCLUSION AND RECOMMENDATIONS

(1) Necessary Items to be Studied for Preparation of LARAP

Based on the result of the site confirmation, project implementation might require 34.2ha of land acquisition in total (17.2ha for permanent facilities construction and 17ha for temporal facilities construction) though involuntary resettlement is not expected. Accordingly, it was concluded that there is no “irreversible environmental negative impacts” to social environment caused by project implementation. Information obtained at the site in the Pre-Feasibility Study is very much limited, and therefore further examination and considerations to the items described below are requested at the next study stage such as feasibility study.

1) Conducting Detailed Household Survey

It was identified at Pre-Feasibility study that involuntary resettlement due to project implementation might not be caused. However, there might be some negative impact to livelihood stabilization due to acquisition of cultivated area or generation of water recession section. Thus, impact level is necessary to be confirmed in detail. For this purpose, it is recommended to conduct detailed household survey described below, as the first step to understand impact due to project implementation as well as baseline information to prepare LARAP;

- i) Population census for confirmation of project affected persons
- ii) Inventory of loss survey for confirmation of property loss due to project implementation, and
- iii) Socio-economic survey to all project affected persons for understanding socio-economic condition (this survey includes confirmation of monthly/annual income, income source, nutrition source, fishing condition and frequency, confirmation of prospects to the project)

Land acquisition might be requested though involuntary resettlement will not be expected at the pre-Feasibility Study. It brings a possibility that socially vulnerable group such as ethnic minority groups will be the target of land acquisition. Thus, confirmation of property ownership and use by socially vulnerable groups at the time of inventory loss survey and socio-economic survey is indispensable. When expected loss might be identified by conducting these surveys, compensation policy including livelihood rehabilitation program is necessary to be examined carefully. In addition, cut-off² date is better to be established at the time of census begins in order to prevent influx of illegal squatters into the project area.

2) Preparation of LARAP

In the case of Japanese ODA project, preparation and disclosure of Resettlement Action Plan (RAP) is necessary if a project requires land acquisition and/or involuntary resettlement in large

² OP4.12 states “Normally, this cut-off date is the date census begins. The cut-off date could also be the date the project area was delineated, prior to the census, provided that there has been an effective public dissemination of information on the area delineated, and systematic and continuous dissemination subsequent to the delineation to prevent further population influx”

scale. In the course of preparation of RAP, consultation with PAPs on project description including expected magnitude due to project implementation and compensation policies shall be made in timely manner.

As for Simanggo-2 project, PLN as the project proponent is requested to prepare Land Acquisition and Resettlement Action Plan (LARAP)³ if it is realized by Japanese ODA and causes land acquisition and/or involuntary resettlement. PLN has experience to prepare LARAP for donor funding projects as described in Chapter 8. Thus, PLN is considered as capable of preparing LARAP by considering JICA guidelines (April, 2010) and World Bank Safeguard Policy OP4.12⁴ as well as reflecting consultation result with PAPs if the final layout of Simanggo-2 requires land acquisition and/or involuntary resettlement. Necessary items to be studied in LARAP are outlined in the Table 15.3.9.

Table 15.3.9 Necessary Items to be Described in LARAP

Item	Contents to be Described
1. Description of the Project	General description of the project and identification of the project area
2. Potential Impact	Identification of potential impacts and establishment of minimizing potential impact
3. Objectives	Objectives to prepare LARAP
4. Socio-Economic Studies	Description of results about census survey and socio-economic survey
5. Legal Framework	Description of relevant regulations and gaps between national regulations and donor policies
6. Institutional Framework	Findings of analysis of the institutional framework to implement land acquisition and resettlement
7. Eligibility	Definition of displaced persons and criteria for determining their eligibility for compensation and other assistance including cut-off dates
8. Valuation of and Compensation for Losses	Methodology to be used in valuing losses to determine their replacement costs, and description supplementary measures to achieve replacement cost if compensation under national law does not meet replacement cost
9. Resettlement Measures	Description of compensation and other resettlement measures
10. Site Selection, Site Preparation, and Relocation (*1)	Preparation of site for relocation.
11. Housing, Infrastructure, and Social Service(*1)	Description of plans to provide necessary infrastructure and social service at the new site if necessary
12. Environmental Protection and Management(*1)	Examination of environmental assessment and environmental management plan for the new site
13. Community Participation	Strategies of community participation from planning to implementation of land acquisition and resettlement
14. Integration with Host Population	Measures to mitigate the impact to resettlement on any host communities
15. Grievance Procedures	Accessible procedures and mechanism for third-party settlement of disputes arising from resettlement
16. Organizational Responsibility	Organizational framework for implementing resettlement
17. Implementation Schedule	Implementation schedule covering all resettlement activities from preparation through implementation
18. Costs and Budget	Estimated cost for all resettlement activities

³ LARAP is generally prepared in the case of land acquisition and/or resettlement is caused at donor funding projects in Indonesia.

⁴ The concept of land acquisition and resettlement in JICA Guidelines (April 2010) applies for the idea of World Bank Safeguard Policy OP4.12. Thus, a project requesting land acquisition and/or resettlement and supported by Japanese ODA is requested to prepare necessary documents to satisfy both of JICA Guidelines and OP4.12.

Item	Contents to be Described
19. Monitoring and Evaluation	Arrangements for monitoring of resettlement activities by the implementing agencies supplemented by independent monitors

Remark: Items marked in *1 are necessary to be examined if relocation and site preparation are necessary.

Source: JICA Study Team based on World Bank OP4.12 Annex A

The draft scope of works for preparation of LARAP which is prepared based on available information at the current study level is enclosed at the Appendix 2 just for referential information though further examination of each work item is necessary at the next study stage.

(2) Necessary Items to be Studied at AMDAL

It was concluded that there is no “irreversible environmental negative impacts” in the stage of Pre-Feasibility Study for the project based on the environmental study. However, the following items should be considered at next step (AMDAL in Feasibility Study for the Project).

1) Detailed Field Survey for Flora and Fauna

Three (3) flora species and five (5) fauna species which categorized as endangered or vulnerable its conservation status according to IUCN were identified through the environmental study. There are certain possibilities that the number of those rare species will be increased with more detailed field survey for flora and fauna.

The additional field survey will be necessary to prepare appropriate environmental mitigation measures against the environmental impact in both construction and operation stages.

Attention shall be paid not only to the rare species, but also the species that are treated as resources for living of the local inhabitants.

2) Detailed Study on Aquatic Environment

It will be necessary to grasp project impact caused by change of the water level in the “water recession section” on aquatic fauna in detail. In addition, actual condition of inland fisheries by local people should be also confirmed in detail.

3) Stake Holders Meeting

The limited interviews to specific persons such as village chiefs were conducted to absorb their preliminary opinions to the project in the environmental study. It is anticipated, however, that opinions of the local people may be variant if their position are different.

Therefore, it is essential that the stake holders meeting with local people from various positions shall be held to obtain their different opinions to the project properly in the stage of Feasibility Study. Local people shall be invited not only from within the project site, but also from the outside but affected by the project, such as downstream of the powerhouse or beneficiary area of power distribution.